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A SYNOPSIS OF THE KANSAS MOSSES WITH KEYS AND DISTRIBUTION MAPS

By
Steven P. Churchill

Vol. 53, No. 1, pp. 1–64 October 22, 1985

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A Synopsis of the Kansas Mosses with Keys and Distribution Maps[1]

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Abstract

There are 151 species of mosses distributed among 77 genera and 31 families in Kansas. The average number of mosses encountered in counties in the west, central and east is 7, 15, and 28, respectively; the percent of species unique to each of these regions is 4, 12, and 32. The Sørensen Similarity Index shows a 83% similarity between species of the east and central, 42% between west and central and only 20% between west and east. The reproductive biology is expressed in types of sexuality (i.e., monoicous or dioicous and success of sporophyte production) and asexuality. The number of species that are dioicous and monoicous is about equal throughout the state. Overall, sporophyte production is greater in monoicous than in dioicous species. A higher number of dioicous species produce sporophytes in the east than in the west. Monoicous species produce sporophytes about equally state-wide. The percent of asexually reproducing species is relatively low for the state, but slightly greater in the west than in the east. Ecological parameters can be expressed as a moisture gradient for the mosses: hydric-9%, mesic-56%, and xeric-34%. Habitat substrates for mosses are: soil and decaying vegetation 70%, saxicolous (rock) 40%, and corticolous (bark) 17%. The North American affinities of the Kansas mosses are: eastern 54%, widespread 29%, western 7%, central 5%, northern 4%, and endemic 1%. Many of the distributions can be attributed to the late-Wisconsinan, and early and mid-Holocene events as well as to the existing physiographic features found in Kansas.

[1] This study is dedicated to a remarkable naturalist and phycologist, the late Dr. Rufus H. Thompson, a University of Kansas faculty member from 1942-1979.

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INTRODUCTION

The Kansas moss flora exhibits an interesting sample of two major biotic regions, the grasslands and the eastern deciduous forests. The position of Kansas offers a nearly uniform east-west transition from the oak-hickory and post-blackjack oak forests in the east with intercalated prairie, to the tallgrass bluestem prairie, the mixed prairie, and the shortgrass prairie plains in the west (see Fig. 4). The transition is due in part to the interaction of physiographic and climatic conditions shaped and modified by the past glacial events. This biotic diversity is correlated with the recorded richness of the Kansas moss flora having a total of 151 species distributed among 77 genera and 31 families.

The first significant account of Kansas mosses was published by Minnie Reed 90 years ago. Studies at that time and later provided a wealth of data, both in the form of collections and in publications that have made possible this present work. This study is the first modern floristic treatment for mosses of any Great Plains state. The entire region of the Great Plains is one of several areas in North America that have been cited as in need of intensive field work (Schofield, 1980). My own field work conducted throughout Kansas resulted in some 2000 collections (see last page of distribution maps for the counties collected in by the author). Particular emphasis was placed on eastern Kansas where more detailed work was required to abut an important work already completed in western Kansas by Smith (1966). I have also examined about 4000 specimens mainly from the New York Botanical Garden (NY), the Missouri Botanical Garden (MO), the Nebraska State Herbarium (NEB), Kansas State University Herbarium (KSC), University of Kansas Herbarium (KANU), and Iowa University Herbarium (IA).

The intent of this synopsis is to provide a guide for the identification of the Kansas mosses, and also to introduce several historical and biological aspects that should be of interest to biologists and naturalists alike. The keys were developed to identify sterile material, i.e., haploid gametophytic leafy plants, but in a few cases some genera or species can only be positively identified with fully developed sporophytes, e.g., *Bruchia* or *Bryum*. While the majority of Kansas mosses can be identified, it is always best when possible to collect material with capsules. The keys are original though much use has been made of existing keys and descriptions. In the preparation of this treatment I have made use of the following texts: Crum, 1976; Grout, 1928-1940; Redfearn, 1972; and Weber, 1973.

The annotated species list includes information on the vegetation type and substrate that the moss is generally associated with. Reproductive information includes the presence of sporophytes (C.fr.) and any specialized asexual features that are present (e.g., gemmae etc.). A subjective estimate is given as to the frequency that a particular moss was observed in Kansas and the distribution is indicated based on the dot maps and extrapolation as to where any particular moss is likely to be found. The county dot maps are based entirely on specimens that I have actually examined in the course of this study. There are three exceptions based on literature records that I have not examined but have accepted: *Atrichum undulatum* based in part on Ireland (1969*a*), *Funaria americana* based in part on Smith (1980), and *Physcomitrium collenchymatum* based on Crum and Anderson (1960). Nomenclature generally

follows Crum et al. (1973), except for the Grimmiaceae (Churchill, 1981) and the Mniaceae (Koponen, 1968). This paper represents the seventh in a series on the mosses of the Great Plains.

History of Moss Collecting and Publications

Kansas has been fortunate to have had a significant number of both naturalists and botanists who collected mosses over a long period of time. Moss collecting in Kansas dates back at least to the 1870's with the collections of Elihu Hall. The decades of 1880 and 1890 were a very active time. Much of the diversity of Kansas mosses became established by several important local collectors, in particular: Joseph Henry (1816-1887), Saline County (very little is known about Henry although he was important in the early botanical history of Kansas); Grace Meeker (?-1948), Franklin County; and Minnie Reed (1867-1959), Pottawatomie, Riley and Wyandotte counties. Minnie Reed contributed more to our early knowledge of Kansas mosses than any other individual. She was born in St. Clere, Pottawatomie County, Kansas in 1867; her parents were farmers. At the age of 15 she entered what is now Kansas State University at Manhattan, earned a B.S. in 1886, and a M.S. in 1893 (see Fig. 1). Little more is known except

Fig. 1. Minnie Reed, seated center. Photograph taken by W. A. Kellerman at Kansas State College, Manhattan, Summer of 1891. Individuals are from left to right: standing, Geo. K. Thompson and C. H. Thompson; seated, Kate (Oldham) Sisson, Minnie Reed, and Elsie (Crump) Ames. Photograph courtesy of Rufus Thompson.

that she was a teacher and died on September 12, 1959 in Los Angeles, California. The publication by Minnie Reed (1893-1894) on the Kansas mosses surely must be one of the very first state moss floras in the United States. Her work is based on collections she made, supplemented by collections made by others (Bartholomew, Beede, Bennett, Knerr, Smyth, McClung, Meeker). Included also were species reported by others such as Renauld and Cardot. A total of 165 species distributed among 50 genera were reported for Kansas by Reed. In addition to keys and illustrations, she provided an introduction to the morphology and history of mosses. Reed obtained assistance on the identification or verification mainly from Elizabeth Britton of the New York Botanical Garden. Reed's study suffered only by the natural inclusion of "species of reports," especially from the publications of Renauld and Cardot (see below), who where less than meticulous in the naming or identification of Kansas mosses sent to them by Joseph Henry (see also section on Kansas types).

While collections were made after the activity of two decades prior to the twentieth century, it was not until shortly before 1950 that further activity was initiated and continued off-and-on until the present time. Recent collectors such as Ronald L. McGregor, Harold L. Smith and the present author have collected widely throughout the state and contributed to an understanding of distribution patterns.

In addition to the significant work by Minnie Reed, another notable work on the Kansas mosses is that by Harold L. Smith (1966). This study included the Great Plains proper and the Arkansas River Lowlands (about the western half of Kansas). Smith's study gives a fine account of the observational aspects of moss ecology and species associations encountered in that region. There is also an account of the minute ephemeral mosses and their possible adaptations to the Plains environment. This is followed by an annotated list of 117 species and varieties, which includes descriptions of habitat and general physiographic areas. The serious deficiency of this work lies mainly with misidentifications, particularly for species reported as new state records. I have indicated these in the synopsis and in the summary of corrections at the end of the synopsis. Also, in Smith's study no locality data were provided for most species, so that distributional information could not be documented.

Other primary publications based on collections are Renauld and Cardot (1892), Gier (1949), McGregor (1950), and Churchill (1979, 1980). Minor publications are Rau (1884, 1885*a*, 1885*b*, 1886), Renauld and Cardot (1888, 1889, 1890*a*, 1890*b*), Smyth (1890, 1891-1892, 1893-1894), Gier (1940), Hartman (1956), McGregor and Hartman (1956), Cridland (1959, 1960), Waller and Bass (1967), Magill and Kirkpatrick (1976), McGregor (1976, 1977), and Churchill (1982). Major catalogues providing lists of the Kansas mosses, usually based on literature reports, are Renauld and Cardot (1892), Smyth (1892), Smyth and Smyth (1911), and Churchill (1976). Unpublished works concerning Kansas mosses are Duncan (1959), Anonymous (1966), and Smith (1961). The unpublished work by Smith (1961) is an important contribution and concerns the mosses of the Chautauqua Hills in southeastern Kansas.

Grüger (1973) reported the only known subfossil mosses for Kansas from the late Wisconsinan that included *Mnium affine* Bland s.l. (= *Plagi-*

omnium), *Mnium seligeri* Jur. (questionable determination; = *Plagiomnium elatum*), *Mnium affine* f. *integrifolium* (Lindb.) Mild. (= *Plagiomnium affine* s.l.), *Calliergon* cf. *sarmentosum* (Wahlenb.) Kindb., and *Bryum pseudotriquetrum* (Hedw.) Gaertn., Meyer & Scherb. between the dates of 24,500 ± 800 BP to 15,880 ± 600 BP.

In the studies by Hartman (1956), Duncan (1959), Anonymous (1966), and McGregor (1976), as far as I am aware, no specimens were collected to verify the study or at least no indication was given that specimens were deposited in any herbaria. For example, the ecological study on the Kansas prairie bryophytes by Duncan (1959), a potentially important study, cites such taxa from prairie sites as *Ditrichum pusillum, Fissidens osmundioides, Helodium paludosum* and *Tortula mucronifolia*—all of which are very likely incorrectly determined! These studies should be used with caution.

The earlier moss collections are now found in scattered herbaria, mostly outside Kansas. The Henry collections are most likely deposited with the Renauld and Cardot collections at Paris, France (PC). I have examined some of these collections, mostly types, as well as some apparent duplicate type collections at the New York Botanical Garden (NY). The majority of the Meeker and Reed collections are deposited at the New York Botanical Garden (NY), although a number of the Reed collections can also be found at Kansas State University (KSC). The entire bryophyte collection of the University of Kansas Herbarium containing 7,224 specimen packets (4,402 mosses and 2,822 liverworts) was donated to the New York Botanical Garden on May 5, 1969. These collections contained all of the specimens collected by both McGregor and Smith as well as a few other individuals. My own work on the Great Plains region, including Kansas, started in the early 1970's with most of my first set of specimens being deposited with the Missouri Botanical Garden (MO). Beginning in 1978 and continuing through mid-1980, the Biological Survey of Kansas initiated a survey of the bryophytes. In addition to a complete set deposited at MO of my collections, a number of duplicates can be found at the University of Kansas Herbarium (KANU); there are also a few collections made by various other individuals contained in KANU. Further representive duplicates of my Kansas collections are deposited at the following herbaria: ALTA, B, CANM, COLO, DUKE, FH, G, HIRO, H, HSC, KRAM, KSC, MICH, MEXU, NEB, NY, SMU, SMS, TENN, UBC, UK, and US. A Great Plains exsiccati, "Musci Planitiebus Incolae," is in preparation by the author and will contain a number of Kansas mosses. This will be distributed by the New York Botanical Garden to 25 institutions (ALTA, B, BA, BM, C, CANM, CBG, COLO, DUKE, F, FH, G, H, KSC, LE, MEXU, MICH, MO, NICH, NY, PC, PE, RM, U and UBC).

Kansas Moss Types and Nomenclatural Combinations

The following list gives the names of various moss taxa named as new to science from collections made in Kansas. These names constitute an important historical and nomenclatural record in the taxonomy of North American mosses. The original name with author and place of publication is listed. I have included the location and habitat of the type if provided with the original publication. Finally the present status of each name is noted.

Amblystegium riparium BS var. *serratum* Ren. & Card. var. nov.
Renauld, F. & J. Cardot. 1889. New mosses of North America. III. Bot. Gaz. 14:98. "Kansas; Saline County, roots of tree (Joseph Henry)." = *Amblystegium riparium* (Hedw.) B.S.G.

Aschisma kansanum Andr. sp. nov.
Andrews, A.L. 1915. Bryological notes I. *Aschisma kansanum,* a new species with remarks upon the genus. Torreya 15:63-67. "Prairies of western Kansas, silicious soil." This species is still accepted; the present author is studying the genus. Holotype: NY!

Atrichum undulatum Beauv. var. *altecristatum* Ren. & Card. var. nov.
Renauld, F. & J. Cardot. 1890. New mosses of North America. IV. Bot. Gaz. 15:58. "Kansas: Saline County (Joseph Henry)." = *Atrichum altecristatum* (Ren. & Card.) Smyth & Smyth. See Ireland (1969*a*, 1970).

Barbula Henrici Rau. sp. nov.
Rau, E.A. 1886. Fourth contribution to the knowledge of Kansas mosses. 5th Report on the Progress of the Washburn College Biological Survey of Kansas. Page 172. "Hab. On rocks, Saline county, (Joseph Henry)." = *Pterygoneuron subsessile* (Brid.) Jur. var. *henrici* (Rau) Wareh. This variety is still recognized. I consider this only a minor form not worthy of taxonomic status.

Campylopus Henrici Ren. & Card. sp. nov.
Renauld, F. & J. Cardot. 1888. New mosses of North America. I. Bot. Gaz. 13:197-198, with Plate 14. "Kansas: Saline County, on sandy ground, where it was discovered by the late Joseph Henry." = *Dicranella heteromalla* (Hedw.) Schimp.

Coscinodon Renauldi Card. sp. nov.
Renauld, F. & J. Cardot. 1890. New mosses of North America. III. Bot. Gaz. 15:41-42, with Plate 6b. "Kansas: Saline county (Joseph Henry)." = *Jaffueliobryum raui* (Aust.) Thér. Lectotype PC! Britton (1890) correctly pointed out that *Coscinodon Ranauldi* was a synonym of the then *Coscinodon raui* (Aust.) Lesq. & James. This species is now considered a member of the genus *Jaffueliobryum* (Churchill, unpub. data).

Fissidens obtusifolius Wils. var. *Kansanus* Ren. & Card. var. nov.
Renauld, F. & J. Cardot. 1890. New mosses of North America. III. Bot. Gaz. 15:40. "Kansas: Saline county (Joseph Henry)." This variety is still recognized, however the status is under investigation by the present author.

Microbyrum Floerkeanum Sch. var. *Henrici* Ren. & Card. var. nov.
Renauld, F. & J. Cardot. 1889. New mosses of North America. III. Bot. Gaz. 14:91. "Kansas: Saline county, on sandy ground (Joseph Henry)." = *Phascum cuspidatum* Hedw.

Physcomitrium kellermanii Britt. sp. nov.
Britton, E.G. 1894. A revision of the genus *Physcomitrium,* with descriptions of five new species. Bull. Torrey Bot. Club 21:204-205, with Plate 200. "Manhattan, Kansas, Kellerman (1889)." = *P. pyriforme* Hedw. sensu Crum et al. (1973), but still recognized by Lawton (1971). Further studies on this genus are warranted to determine the range of phenotypic variation. This moss was named in honor of William Kellerman (1850-1907), a noted mycologist and a member of the faculty of Kansas State Agriculture College at Manhattan (Willard, 1909).

Ptychomitrium pygmaeum Lesq. & James sp. nov.
Lesquereux, L. & T.P. James. 1878-1879. Description of some new species of North American mosses. Proc. Amer. Acad. of Art & Science 14:136. "Hab. Near the Neosho River, Kansas, and at Bolivar, Missouri (E.

Hall)." = *P. incurvum* (Schwaegr.) Sull.

A number of nomenclatural combinations for mosses were made by Smyth and Smyth (1911) in a catalogue of the Kansas flora. These combinations were brought to my attention by Dr. Ronald McGregor, University of Kansas, and their validity was verified by Dr. Marshall Crosby, Missouri Botanical Garden. The names are listed as they originally appeared in the catalogue by Smyth and Smyth (op. cit.). Each name is annotated as to its present status.

Fissidens Kansanus Ren. & Card.
This appears to be a new combination based on the variety originally recognized by Renauld and Cardot (1890). The proper citation should be *Fissidens kansanus* (Ren. & Card.) Smyth & Smyth. = *F. obtusifolius* Wils. var. *Kansanus* Ren. & Card.

Mnium elatum (B. & S.)
Apparently based on *Mnium affine* Funck var. *elatum* B.S.G. = *Plagiomnium elatum* (B.S.G.) Kop.

Atrichum altecristatum (R. & C.)
Based on *Atrichum undulatum* (Hedw.) P. Beauv. var. *alte-cristatum* Ren. et Card. The proper citation should be *A. altecristatum* (Ren. & Card.) Smyth & Smyth. The combination by Smyth and Smyth (op. cit.) supersedes that of Ireland (1970).

Brachythecium acuminatum (Hedw.)
This combination was made earlier by Austin.

Brachythecium setosum (S. & L.)
The combination apparently based on Hedwig's *Leskea setosa* Hedw. = *Brachythecium acuminatum* (Hedw.) Aust.

Eurhynchium hians (Hedw.)
Combination made earlier by Sande-Lacoste in 1866.

Rhynchostegium serrulatum (Hedw.)
The combination by Smyth and Smyth is superseded by Jaeger in 1878.

Amblystegium orthocladon (Beauv.)
This combination was made earlier in 1892 by Macoun. This taxon is presently not known for Kansas. Probably can be referred to *A. tenax.*

(?) *Amblystegium irriguum* (Hook. & W.)
Bruch, Schimper and Guembel made this combination in Bryologia Europeae in 1855.

Amblystegium adnatum (Hedw.)
This combination was made earlier by Austin in 1870. = *Homomallium adnatum* (Hedw.) Broth.

Amblystegium cariosum (Sull.)
Based on *Hypnum riparium* Hedw. var. *cariosum* Sull. in Rau. = *Amblystegium riparium* (Hedw.) B.S.G.

Amblystegium serratum (R. & C.)
Smyth and Smyth combination based on *A. riparium* (Hedw.) B.S.G. var. *serratum* Ren. & Card. = *Brachythecium acutum* (Mitt.) Sull. This *Brachythecium* is not known for Kansas; if it is a species of *Brachythecium,* then it is likely to be *B. acuminatum* (Hedw.) Aust. since the Renauld and Cardot type was collected in tree roots.

Campylium chrysophyllum (Brid.)
Combination made earlier by J. Lange in 1887.

Harpidium aduncum (Hedw.) = *Drepanocladus aduncus* (Hedw.) Warnst.

Diversity, Distribution and Biogeography

The accumulated data on the mosses of Kansas are sufficient to permit analyses of species diversity and patterns. The pattern of diversity of the Kansas mosses exhibits an expected decrease in species richness from east to west. To gain some quantitative expression of this, the two vertical tiers of counties both in the east and west, plus three central tiers of counties were examined for the number of species present in each county (Fig. 2). The mean average calculation exhibited a halving

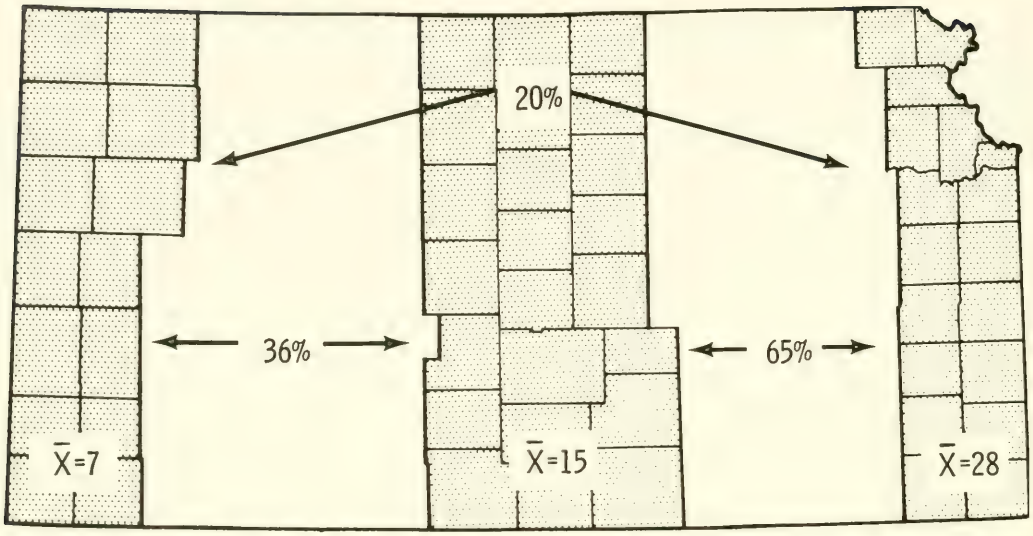

FIG. 2. Diversity of the Kansas mosses. Means based on numbers of species per county. Percentages of similarity for any two areas based on the Sørensen Similarity Index[1] (see text for further discussion).

[1]($IS_s = C/\frac{1}{2}(A + B) \times 100$) where IS_s = Sørensen's Index of Similarity, c = number of species held in common by 2 areas, A = total number of taxa in first region, B = total number of taxa in second region.

from the east to the central zone, and again from the central to the west zone. This appears to be a characteristic pattern and probably true of various groups of taxa. The number of species unique to each zone shows a similar pattern: the east zone with 32%, the central zone with 12%, and the west zone with 4%. The Sørensen Similarity Index was used to examine relationships between the three zones (Fig. 2). The similarities between the east and central zones were highest (83%), while the similarity between west and central zones were nearly half of the first (42%), and finally 20% similarity existed between the east and west zones.

The methods used to examine the distribution patterns and the biogeography involve consideration of only those species that have been collected well enough to permit analysis. Those species that are found throughout (i.e., showing a ubiquitous distribution) are not considered (ca. 20 species). Taxa known only from a few localities are used but with caution. In any biogeographical study the main process is the search for recurring patterns, whether the emphasis is ecological (MacArthur, 1972) or historical (Croizat, 1964). Once the patterns are established, the second phase involves hypothesis testing.

The 151 species can be divided into several broad distributional categories, each of which have several subcategories. To obtain a better impression of the patterns in the distribution of Kansas mosses, 52 distributions were superimposed on the same map—this produced a number of recurrent patterns. These patterns have been reduced to five major patterns and are characterized by the following representative species: (1) widespread western distribution—*Aloina rigida, Barbula acuta, Didymodon rigidulus, Hypnum vaucheri, Jaffueliobryum raui, J. wrightii, Pterygoneurum subsessile,* and *Tortula ruralis;* (2) broadly eastern distribution—*Anomodon attenatuas, A. minor, A. rostratus, Atrichum angustatum, Brachythecium oxycladon, Campylium chrysophyllum, Entodon compressus, E. seductrix, Hedwigia*

ciliata, Homomallium adnatum, Leskea gracilescens, and *Lindbergia brachyptera.* The remaining southeastern or easternmost distributions represent varying degrees of the eastern distribution: (3) extreme eastern—*Aulacomnium heterostichum, Bartramia pomiformis, Bryum pseudotriquetrum, Climacium americanum, Dicranum scoparium, Plagiomnium ciliare, Pohlia nutans,* and *Thuidium delicatulum;* (4) mostly southeastern—*Drummondia prorepens* and *Leucodon julaceous;* and (5) sandstone sites in extreme east central —*Atrichum oerstedianum, Bryhnia graminicolor, Bryoandersonia illecebra,* and *Diphyscium foliosum.*

What remains is to develop a hypothesis which will allow for the most parsimonious explanation of the extant moss distributions in Kansas. To do so, we must also consider the North American affinities of the Kansas mosses and the historical events that led up to the patterns we see today. The broad North American affinities for the Kansas mosses are as follows: 54% of the Kansas mosses are eastern, 29% are widespread, 7% are western, 5% are central, 4% are northern, and 1% are endemic. These percentages compare roughly to that given for the Kansas vascular plants (Table 1). This correlation suggests an important point about the nature of moss distributions.

First of all, the distribution of the mosses is most often the same as those of vascular plants (Anderson, 1971; Crum, 1972). This distribution has been influenced by primarily historical events, particularly of the late Quaternary period. Mosses are not haphazard in their distribution, and the chance of long-distant dispersal, not unlike the insects discussed by Udvardy (1969), are probably less than 1%. While it is difficult for the dispersalist to understand, the chance of long-distance dispersal is the exception (but verified by

Table 1. Percentage of the North American affinities of the Kansas mosses and vascular plants. Vascular plant data modified from Bare and McGregor (1970); based on 479 species.

Region	Mosses	Vascular plants
Eastern	54	49
Widespread	29	14
Western	7	17
Central	5	8
Northern	4	13
Endemic	1	0
Southern	0	9

a *few* islands), while continental landforms provide evidence for the *rule*! The controlling factors of distribution (up to the level of biotic formation) are climate and geographical/geological factors.

The influence of the Pleistocene period on extant distributions is best documented by Wisconsinan and post-Wisconsinan studies. Earlier periods of the Quatenary are less well known. Kapp (1965) does however present evidence concerning the Illinoian glacial and Sangamon interglacial of northwest Oklahoma and southwest Kansas. The evidence is meager but suggests the existence of *Picea* and *Pinus* during the Illinoian in this region, while in the Sangamon there was marked decrease of *Picea* and some decline of *Pinus.* This, together with the earlier work by Hibbard (1955) on fossil vertebrates, suggests a rather mesic environment for this area compared to the present interglacial.

The Wisconsinan and Holocene are better documented for Kansas, at least the eastern region. Grüger (1973) studied two sites in northeastern Kansas. Dates on the strata for which micro- and macro-fossil material were collected indicate *Picea* in the area from

about 23,000 yr. BP to at least 15,000 yr. BP. So dates are available for the Wisconsinan maximum and the early Holocene times. From the studies by Grüger (1973), Stewart (1979), and others, a hypothesized Wisconsinan glacial maximum vegetation for Kansas and adjoining states has been proposed by P.V. Wells (unpubl. map). This includes Rocky Mountain Conifer in central and most of the west in Kansas, while northwest and eastern Kansas was composed of Taiga (Fig. 3). Areas further south and southeast of Kansas were thought to be composed of transitional Taiga-Deciduous forests. It was some time after 15,000 yr. BP that prairie-deciduous elements entered northeastern Kansas replacing the Taiga vegetation. To the west, the Rocky Mountain Conifer contracted and the grasslands expanded. During this period (10,000 to 5,000 yr. BP) the climate apparently became arid, marked by increased grass and composite pollen in the studies by Grüger. Northeastern Kansas then assumed an appearance that one generally sees to-

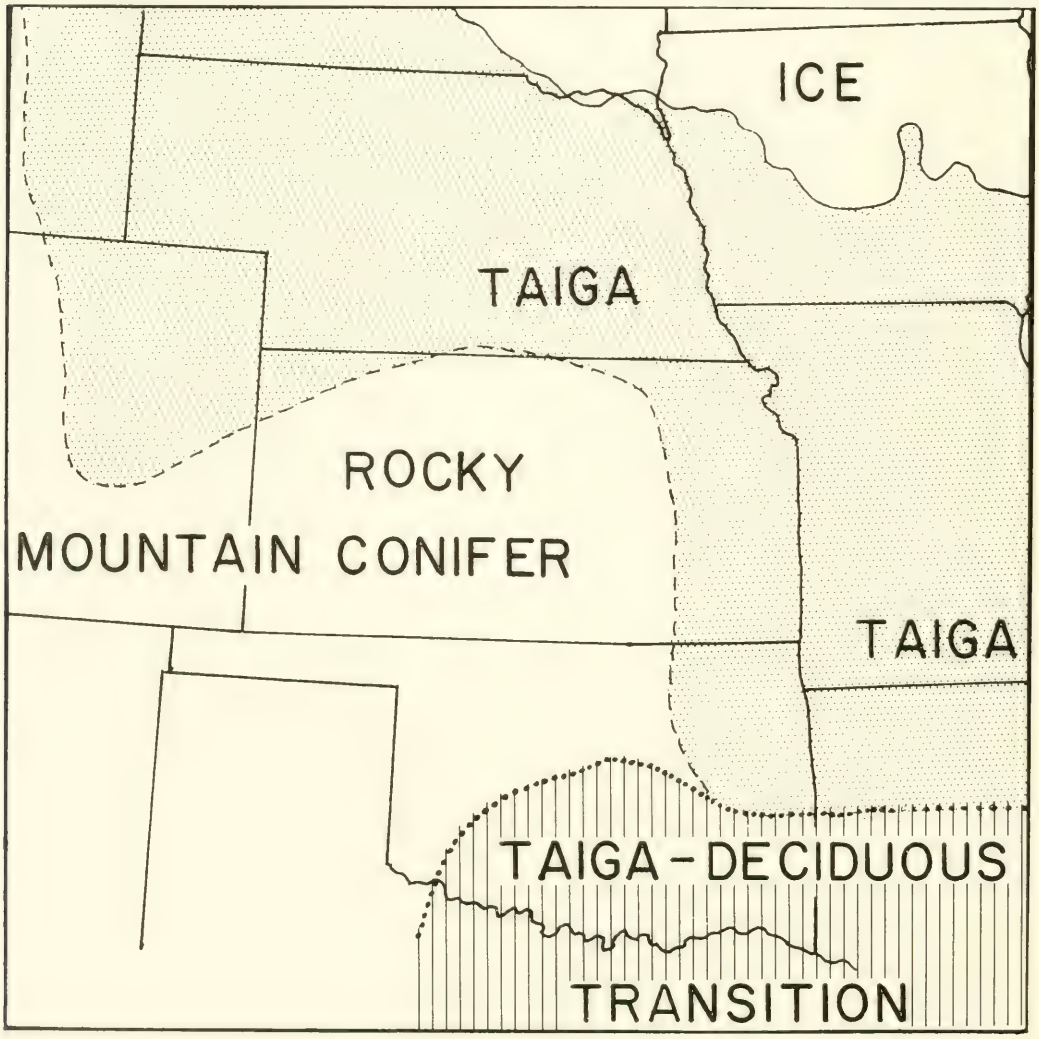

FIG. 3. Past vegetation of Kansas and surrounding states, ca. 14,000 yrs BP (courtesy of P. V. Wells, unpubl. map).

day with transitional prairie and oak-hickory forest (Fig. 4; see Küchler, 1974, for a detailed description of Kansas vegetation). A similar sequence of events was recorded by King (1973) for the western Missouri Ozarks.

The distribution patterns of the Kansas mosses based on the evidence of the Quaternary events can be summarized. Western and central (more xeric types) elements could have been derived from the south or southwest in one or two periods of aridity at the close of the Wisconsinan or during the Hypsithermal. Although it is possible that these elements were already associated with the Rocky Mountain Conifer as they are today in the Pine Ridge of western Nebraska. Associated western elements include such genera as *Barbula, Didymodon, Hypnum, Jaffueliobryum, Pterygoneurum* and *Tortula.* Eastern and northern elements were likely associated in part with the Taiga in eastern Kansas during the maximum Wisconsinan. Several of the Kansas mosses are today found commonly in the southern Taiga forests of Canada as well as the eastern deciduous forests farther east; examples include *Aulacomnium, Bartramia, Bryum, Dicranum, Leucobryum, Pohlia,* and *Thuidium.* Other taxa more typical of the rich eastern deciduous forests include *Anomodon, Campylium, Drummondia, Entodon, Homomallium, Leskea, Leucodon* and

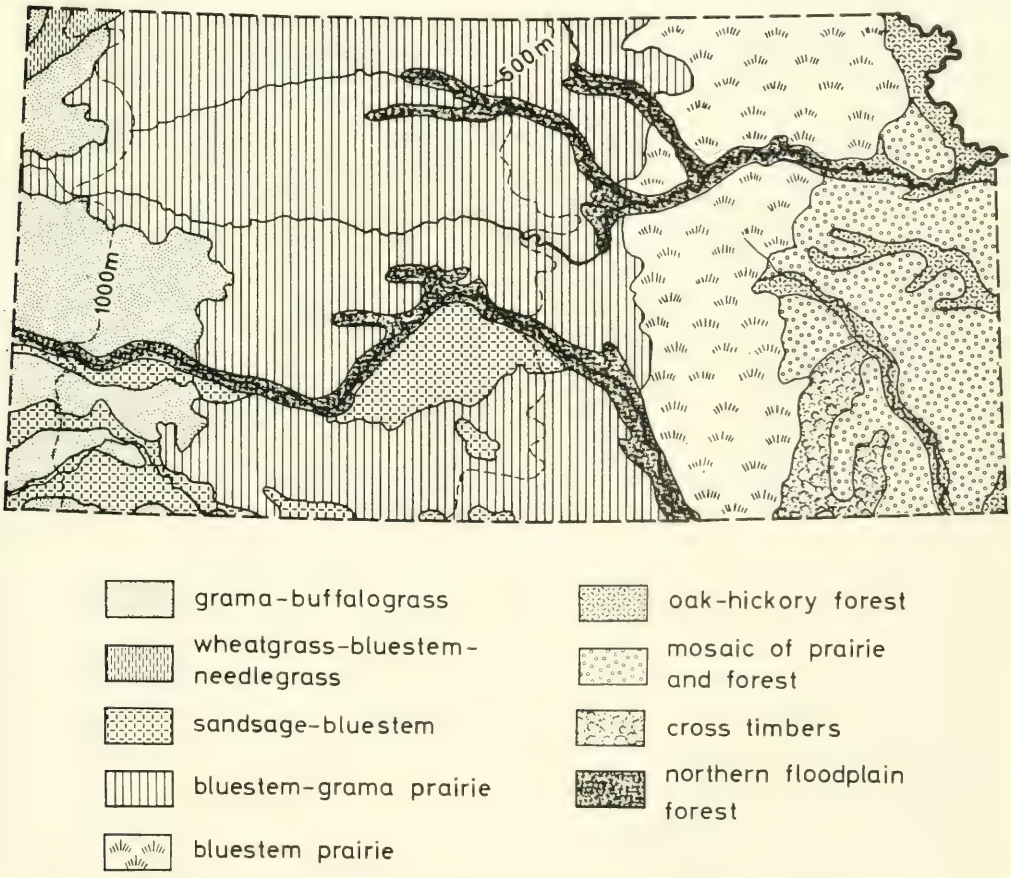

Fig. 4. Vegetation of Kansas. (From Küchler, 1972. Used with permission of author.)

Lindbergia; these taxa may have been associated with the Taiga-Deciduous transition farther to the south. A somewhat anomalous pattern is exhibited by *Grimmia teretinervis* Limpr. and *Tortula cainii* Crum & Anderson. *Grimmia teretinervis* is known from central Oklahoma, southwest Missouri, central Kansas, disjunct to southeastern Minnesota and in Canada it is known from Alberta and from Quebec. *Tortula cainii* is known from central Kansas and Ontario. In the plains both species are found on calcareous substrates in arid grasslands. The southern populations could have provided the source for the more northern populations in Minnesota and Canada once the ice sheet retreated farther north, although southwest Minnesota is closely associated with the driftless area and populations there may have persisted through the last glaciation. It is also interesting to note that both these species are dioicous, with the sporophytes presently unknown, so that these species may have dispersed via fragmentation of the haploid gametophyte.

The increased aridity possibly associated with fire (Wells, 1970) isolated not only the elements of the Taiga but those elements associated with the eastern deciduous forest that in time also declined. The mosses that survived the rapid changes associated with the close of the Wisconsinan and early Holocene became isolated in microhabitat sites, often on sandstone or limestone escarpments.

Corroboration of the hypothesis concerning the moss distribution is provided by evidence from the paleoecology (especially Grüger, 1973) as well as the similarity in patterns among the vascular plants. Other groups of organisms are needed to test the hypothesis presented here to provide a more complete picture of Kansas and plains biogeography.

Reproductive Biology

The ecological range found in an east-west transition from a mesic forest biotic province to a xeric grassland biotic province is readily apparent. In the Kansas mosses this is correlated with a three-fold decrease in species diversity from east to west (Fig. 2). It is expected that certain correlative patterns might exist in the mode of reproduction in the Kansas mosses also.

Two equally common modes are found in moss reproduction—sexual and asexual. Sexual reproduction requires water to transport the sperm from the antheridium to the egg of the archegonium. Mosses may be either dioicous or monoicous. In dioicous species the antheridium and archegonium are on separate plants. In monoicous species the arrangement of antheridial and archegonial inflorescences on the same plant can be arranged in at least four basic types, from mixed to completely separate on the plant (an excellent outline of the sexual types is presented by Anderson, 1980). An advantage of the dioicous condition would be an increase in genetic recombination but as Anderson (1980) has pointed out, fertilization becomes a major obstacle. This is due to the short-lived nature of sperm and the short distance that can be crossed by free-swimming sperm. In monoicous species the chance for fertilization would be greatly enhanced, albeit with the loss of genetic variability. Distance to be traveled and water then become critical limiting factors. Given the wide range of vegetational and climatic conditions between the extreme east and west (see Fig. 2 for the location of the east and west zones) one might predict a shift with a greater number of monoi-

cous species to be found in the west than dioicous species. In the Kansas mosses the percentage of dioicous or monoicous species is nearly equal (52% and 48%, respectively) and there is, in fact, little difference between east and west (Table 2).

A further consideration is the sporophyte production found in eastern vs. western Kansas. Overall the number of species that are known to produce sporophytes in Kansas is 60% and little difference is found between east and west—67% of the species in the east, and 60% of the species in the west are known to produce sporophytes. It is only when both sporophyte production and sexual condition are considered that a notable pattern appears. The percent of monoicous sporophyte success in both the east and west is greater (83% and 85%, respectively) than that of dioicous sporophyte success. This is also true of the total species in Kansas. The western dioicous sporophyte success is notably lower than that found in the east (33% vs. 52%).

A final parameter of reproduction involves asexuality. A distinction is made between species that typically produce asexual structures, e.g. gemmae, etc., and those species that can reproduce via fragmentation. The total percentage of species producing specialized asexual structures is relatively low (7%) for Kansas (Table 2). Total percentage for eastern North America has been calculated by Crum (1972) to be 15% based on some 697 species. The sexuality of the asexual producing species shows a more prevalent occurrence for dioicous species over that of the monoicous species (Table 2). The factor of regeneration via fragmentation probably plays an important role in the mosses found in Kansas, especially in the western xeric region. Mosses, particularly the xeric species, are known to be capable of regeneration after 5-10 or more years (for a good discussion of this subject see Crum, 1972). Smith (1966) tested 32 species from western and central Kansas for regeneration; 17 species showed such a capacity. It is very likely that the arid plains and prairies exhibit an analogous situation of dispersal and reproduction as Miller and Ambrose (1976) reported for the Arctic. They suggested that wind plays an important role in disseminating bryophytes that

Table 2. Percentage comparison of reproductive modes in Kansas mosses. Comparison made with all of Kansas (Kansas), the eastern two tiers of counties (East Kansas) and western two tiers of counties (West Kansas). C.fr. = plants with sporophytes present.

Reproductive mode	Location		
	East Kansas	West Kansas	Kansas
Dioicous	53	48	52
Monoicous	47	52	48
C.fr.	67	60	60
Dioicous c.fr.	52	33	52
Monoicous c.fr.	83	85	82
Asexual	4	8	7
Dioicous asexual	7	8	5
Monoicous asexual	4	8	2

had fragmented, and "particularly in a non-forested area where wind may be unchecked by other than topographic barriers. Under such conditions both local and long-distance dispersal may take place." While it is questionable that long-distance dispersal may be involved in the Great Plains, certainly local dispersal is possible especially in such taxa as *Barbula acuta, Ceratodon purpureus, Tortula ruralis* etc., that rarely produce sporophytes but are widespread in the High Plains region.

KEY TO THE GENERA OF KANSAS MOSSES

1. Plants whitish; tip branches forming a compact head (capitulum); green cells encompassed by hyaline cells; aquatic or of wet habitats . . . . . *Sphagnum*
1. Plants lacking above combination of characters and habitat type 2
   2. Plants dendroid, large, 3-6 cm tall; plants connected by underground stems; leaves serrate, base clasping . . . . . *Climacium*
   2. Plants not dendroid and lacking remaining combination of characters . . 3
3. Plants usually trailing and many branched, with a pleurocarpous habit (sporophyte produced laterally on branch not at apex) 4
3. Plants usually upright, with an acrocarpous habit (sporophyte produced at tip of branch) 33
   4. Leaves ecostate (lacking a costa) 5
   4. Leaves costate (sometimes confined to base and then often forked) 9
5. Plants dull gray to black; leaves arranged in 3 rows; aquatic . . . . . *Fontinalis*
5. Plants green to dark green, shiny or dull; leaves appearing in more than 3 rows; usually not aquatic 6
   6. Alar cells conspicuously differentiated, enlarged, often yellow to golden yellow; operculum long rostrate . . . . . *Sematophyllum*
   6. Alar cells inconspicuous, not enlarged 7
7. Leaf tip hyaline serrate; cells incrassate (thick-walled), with 1-2 papillae (often branched) . . . . . *Hedwigia*
7. Leaf tip not hyaline; cells incrassate or not, smooth not papillose 8
   8. Branch leaves large, usually 1-2 mm or more long; on trees in eastern Kansas . . . . . *Leucodon*
   8. Branch leaves small, usually 0.5 mm long; costa often present or appearing absent; on soil or rock in western Kansas . . . . . *Pseudoleskeella*

PLEUROCARPOUS; LEAVES COSTATE

9. Leaf cells smooth, not papillose 10
9. Leaf cells papillose or mammillose 27
   10. Costa short, single or double, not extending above leaf middle 11
   10. Costa single, beyond leaf middle 18
11. Leaves squarrose, acumen channeled . . . . . *Camplylium*
11. Leaves not squarrose or channeled 12
   12. Leaves falcate; alar cells differentiated . . . . . *Hypnum*
   12. Leaves not falcate; alar cells usually not differentiated 13
13. Plants strongly julaceous or complanate 14
13. Plants not strongly julaceous nor complanate 15

14. Leaves broadly ovate, in cross-section strongly concave, apex acute to shortly acuminate . . . . . *Entodon*
14. Leaves ovate-lanceolate, weakly concave, apex short to acuminate . . . . . *Taxiphyllum*
15. Leaves dark green to brown, with a sheen; plants producing brood branchlet in leaf axil; on decaying logs or living trees . . . . . *Platygyrium*
15. Plants lacking above combinations, never with brood branchlets (occasionally on *Homomallium*) 16
16. Alar region of inflated cells, often colored light to dark golden; operculum long rostrate . . . . . *Sematophyllum*
16. Alar region not inflated, color nearly the same as median region although lighter 17
17. Plant branches erect and curved in one direction (falcate); capsule curved; on bark and decaying logs . . . . . *Pylaisiella*
17. Plant branches ± flat; capsule straight; generally on rocks . . . . *Homomallium*

Pleurocarpous; Costa Single and Beyond the Leaf Middle

18. Leaves falcate-secund; alar region inflated . . . . . *Drepanocladus*
18. Leaves not falcate-secund; alar region not inflated, may be differentiated 19
19. Leaves squarrose, usually with a channeled leaf tip, alar cells quadrate distinct from median . . . . . *Campylium*
19. Leaves wide-spreading to patent, not squarrose, lacking a channeled leaf tip, alar cells differentiated gradually 20
20. Plants forming a near complanate habit; leaf apex distinctly twisted; margins serrated; on soil, decaying logs, base of trees . . . . *Rhynchostegium*
20. Plants lacking above combinations; leaf apex not twisted (except *Bryoandersonia*) 21
21. Plants with indistinct creeping strand with apparent ascending leafy branches; leaf cells rounded; on trees . . . . . *Drummondia*
21. Plants lacking above combinations; leaf cells not rounded, usually short to long rhombodial, linear or oblong; on various substrate 22
22. Leaves lanceolate, very small (up to 1.2 mm), costa nearly precurrent; leaf margins slightly to distinctly serrate, especially at base; brood-bodies usually present on leaf tips . . . . . *Rhynchostegiella*
22. Leaves lacking above combinations, brood-bodies never present 23
23. Leaves ovate-lanceolate, tip long acuminate; margins distinctly irregularly dentate; usually found above base of trees . . . . . *Fabronia*
23. Leaves usually lanceolate to ovate-lanceolate; regularly serrate if toothed; various substrates but usually not trees 24
24. Leaves julaceous, deeply concave, ovate to round-ovate . . . *Bryoandersonia*
24. Leaves not julaceous, slightly or not at all concave, lanceolate 25
25. Leaves plicate; alar cells distinctly quadrate, median cells long rhombodial or linear . . . . . *Brachythecium*
25. Leaves smooth, not plicate; alar cells usually not distinct, median cells shortly rhombodial 26
26. Apex cells shorter than median cells; margins distinctly serrate . . . . . *Eurhynchium*

26. Apex cells as long as median cells; margins smooth to slightly dentate . . . . . *Amblystegium*

PLEUROCARPOUS; LEAF CELLS PAPILLOSE OR MAMMILLOSE

27. Leaf cells papillose on back only (lower or abaxil surface) . . . . . *Bryhnia*
27. Leaf cells papillose or mammillose on both surfaces 28
28. Leaf cells pleuripapillose (several papillae per cell) . . . . . *Anomodon*
28. Leaf cells unipapillose 29
29. Leaf tip hyaline; plants loose and scattered, usually on upper tree trunks . . . . . *Lindbergia*
29. Leaf tip not hyaline (if hyaline then leaves broadly ovate, i.e. *Thelia*); if on trees then at base 30
30. Plants lacking or with only a few scattered paraphyllia; papillae low, slightly bulging . . . . . *Leskea*
30. Plants with abundant paraphyllia; papillae usually very distinct 31
31. Leaf apex cell with 2 (3) papillae; plants distinctly 1- several pinnately branched . . . . . *Thuidium*
31. Leaf apex cell with 1 papillae; plants indistinctly pinnate or once pinnate . . 32
32. Plants julaceous; leaves broadly ovate, often with cilia on margins; papillae high and often branched . . . . . *Thelia*
32. Plants not julaceous, leaves generally narrowly ovate, margins lacking cilia; papillae low and not branched . . . . . *Haplocladium*

ACROCARPOUS (SPOROPHYTE USUALLY PRODUCED AT TIP OF STEM OR BRANCH)

33. Leaves lacking lamellae on adaxial (upper) surface 39
33. Leaves with lamellae present on adaxial surface 34
34. Lamellae filamentous, simple or branched, not in rows; leaf tip cucullate; leaves short, 1-2.5 mm long . . . . . *Aloina*
34. Lamellae in rows, of few to several cells high; leaf tip acuminate to acute-rounded; leaves mostly longer than 2.5 mm 35
35. Leaves ovate to spatulate, with hyaline hair point; lamellae 2-4 . . . . . *Pterygoneurum*
35. Leaves lanceolate, with hyaline hair point generally lacking; lamellae mostly greater than 4 36
36. Lamellae forming 4-6 (8) rows; leaf base not distinctly expanded nor sheathing . . . . . *Atrichum*
36. Lamellae forming more than 10 rows; leaf base expanded and sheathing 37
37. Leaves 1.5-3.5 (4) mm long; capsule cylindrical . . . . . *Pogonatum*
37. Leaves (4) 4.5-8 (10) mm long; capsule angled 38
38. Lamellae terminating with a square cell . . . . . *Polytrichastrum*
38. Lamellae terminating with a distinct notched or rounded cell . . . . . *Polytrichum*
39. Leaf cells smooth 40
39. Leaf cells mammillose or papillose 60
40. Plants ephemeral, small, very inconspicuous; capsules cleistocarpous (lacking a defined capsule mouth and operculum—lid); and seta equal or shorter than pericheatial leaves (except *Anomobryum*) 41

40. Plants larger, conspicuous; capsules stegocarpous (well defined capsule mouth and operculum); and seta usually longer than perichaetial leaves 46*
41. Leaves broadly ovate 42
41. Leaves lanceolate to linear 43
42. Leaves julaceous, shiny golden brown, apex acute to ovate . . *Anomobryum*
42. Leaves not julaceous, green, acuminate . . . . . *Pyramidula*
43. Leaves setaceous; costa extending well beyond lamina; capsule round-ovoid, a distinct neck absent . . . . . *Pleuridium*
43. Leaves linear to lanceolate; costa ending at tip or just beyond 44
44. Costa excurrent; capsule pyriforme, neck region distinct. . . . . *Bruchia*
44. Costa precurrent; capsule ovoid-rounded, neck region lacking 45
45. Leaf margins irregularly serrated; spores less than 100 um . . . . . *Ephemerum*
45. Leaf margins smooth to evenly dentated; spores about 200 um . . . *Archidium*
46. Leaf margins differentiated, usually a border of linear cells longer or different from median cells 47
46. Leaf margins similar to median cells, or very indistinctly differentiated. 50
47. Leaves linear-lanceolate; costa long excurrent; capsule pyriforme. . . . . *Leptobryum*
47. Leaves lanceolate-ovate to oblong; costa not long excurrent 48
48. Leaves distinctly serrate from base or middle to apex. . . . . *Plagiomnium*
48. Leaves smooth or only serrate in upper third. 49
49. Leaves large, up to 8-10 mm long; forming a distinct rosette of leaves . . *Rhodobryum*
49. Leaves medium up to 5 mm long; not forming a rosette of leaves . . . . *Bryum*
50. Basal leaf cells differentiated, usually ± inflated and rusty golden yellow . . . . . *Dicranum*
50. Basal leaf cells not differentiated. 51
51. Leaves setacous to linear 52
51. Leaves lanceolate to ovate, ovate-oblong 53
52. Lamina extending only a fifth or less along the long excurrent costa; capsule not constricted below mouth; annulus large and compound. . *Ditrichum*
52. Lamina extending half or more along the costa length; costa excurrent or precurrent; capsule constricted below mouth; annulus small or absent . . . . . *Dicranella*
53. Leaf median cells isodiametric 54
53. Leaf median cells rhomboidal to linear 58
54. Leaves oblong to oblong-ovate, margin sharply serrate from middle to apex; costa ending several cells below apex . . . . . *Aulacomnium*
54. Leaves oblong-lanceolate to lanceolate, margins smooth to dentate or bluntly serrate; costa precurrent or if ending several cells below apex then indistinctly so 55

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* Couplet inadvertently left out.

Leaves several layers thick, outer layers composed of empty hyaline cells surrounding a central layer of green cells; plants pale to white, forming cushions . . . . . *Leucobryum*

Leaves lacking the above combinations of characters, plants various in color and habit. 46

55. Leaf apex hyaline, either a short or long awn 56
55. Leaf apex lacking a hyaline tip. 57
56. Leaves ovate, apex acute to rounded; unistratose; calyptra campanulate . . . . . *Jaffueliobryum*
56. Leaves lanceolate to oblong-lanceolate, apex acute to acuminate; partially bistratose; calyptra cucullate . . . . . *Grimmia*
57. Leaf base ± ovate, upper half becoming narrow and acuminate, apex not notched . . . . . *Barbula*
57. Leaf base and upper half continuous, not notably differentiated, gradually acuminate; apex notched; capsule curved and grooved . . . . . *Ceratodon*
58. Leaves lanceolate to ovate-lanceolate; either cells long rhomboidal or plants pale green . . . . . *Pohlia*
58. Leaves oblong-ovate to obovate; plants neither with long cells or pale green 59
59. Capsule inclined, mouth small, peristome present; costa usually ending in apex or shortly excurrent . . . . . *Funaria*
59. Capsule erect, mouth large, peristome absent; costa usually ending several cells below apex . . . . . *Physcomitrium*

LEAF CELLS PAPILLOSE OR MAMMILLOSE

60. Leaf margins incurved throughout 61
60. Leaf margins plane or recurved 62
61. Capsule immersed among leaves, cleistocarpous. . . . . *Astomum*
61. Capsule exserted above leaves, stegocarpous . . . . . *Weissia*
62. Leaves ecostate, silver-gray green color; on sandstone rock . . . . *Hedwigia*
62. Leaves costate, variously colored; substrate various. 63
63. Leaf margin distinctly serrate (occasionally serrulate) 64
63. Leaf margin smooth (rarely dentate, if so usually toward apex). 70
64. Margin serrate at juncture of hyaline and papillose cells . . . . . *Eucladium*
64. Margin serration not confined to juncture. 65
65. Leaf sheath distinct, of hyaline cells, upper lamina cells mammillose; calyptra often remaining attached to mature capsule neck . . . . . *Timmia*
65. Leaf lacking a differentiated sheath and upper lamina; calyptra never attached to mature capsule. 66
66. Leaf median cells oblong-linear, papillose at lower and/or upper ends of cell . . . . . *Philonotis*
66. Leaf median cells quadrate-rounded, papillae not confined to ends of cells. 67
67. Leaf oblong to spatulate; brood-bodies present in leaf axil . . . . . *Hyophila*
67. Leaf lanceolate to linear; brood-bodies absent. 68
68. Plants very small, up to 2.0-2.5 mm tall; capsule cleistocarpous; protonema persistent . . . . . *Ephemerum*
68. Plants larger, usually over 4 mm tall; capsule stegocarpous; protonema not persistent. 69
69. Leaves oblong-lanceolate, serrate only at apex; stalked propagula usually present; marshes and swamps. . . . . *Aulacomnium*
69. Leaves linear-lanceolate, serrate except at base; propagula absent . . *Bartramia*

70. Leaf hyaline basal cells extending up along margin, forming a V-shape; leaves oblong-lanceolate . . . . . *Tortella*
70. Leaf hyaline basal cells not forming a V-shape; leaves variously shaped 71
71. Leaf cells with mammillae or papillae rounded, not C-shaped. 72
71. Leaf cells with papillae C-shaped 78
72. Plants small, up to 2 mm tall; confined to margin of clear or white quartz pebbles; cleistocarpous. . . . . *Aschisma*
72. Plants larger, 4 mm or more tall; not confined to quartz pebbles; stegocarpous 73
73. Upper leaf cells partly bistratose; basal cell walls thick; costa shortly excurrent to precurrent; capsule immersed among leaves; columella remaining attached to operculum . . . . . *Schistidium*
73. Plants lacking above combination of characters; never with columella remaining attached to operculum. 74
74. Plants producing propagula. 75
74. Plants not producing propagula 76
75. Propagula present in leaf axils, round, not stalked; leaves lanceolate, costa precurrent . . . . . *Didymodon*
75. Propagula present on leaf, clavate, stalked; leaves ovate-lanceolate. . . *Barbula*
76. Leaves strongly decurrent; apex obtuse to rounded; costa ending below apex; plants of wet, calcareous sites . . . . . *Didymodon*
76. Leaves not or very short decurrent; apex various; costa usually precurrent to excurrent; plants not of wet sites. 77
77. Costa ending just below apex or excurrent in a short hyaline awn; peristome teeth in 8 pairs; calyptra plicate, often hairy; plants on trees or limestone rock . . . . . *Orthotrichum*
77. Costa precurrent or excurrent but not hyaline; peristome of 16 divided teeth; calyptra smooth, not hairy; plants on soil, rarely on sandstone or limestone rock. . . . . *Barbula*
78. Leaves oblong-lanceolate; apex acuminate, ending in a short awn; cleistocarpous; seta shorter than capsule; on soil . . . . . *Phascum*
78. Leaves oblong to oblong-ovate, rarely oblong-lanceolate; apex acute or often abruptly rounded to obtuse; stegocarpous; seta longer than capsule; on various substrate 79
79. Propagula present in leaf axils; on trees . . . . . *Tortula*
79. Propagula absent; not on trees 80
80. Leaves apiculate or mucronate, not ending in a hyaline awn 81
80. Leaves long excurrent, ending in a hyaline awn 82
81. Leaf tip reflexed and pinched; costa ending below apex . . . . . *Tortula*
81. Leaf tip not reflexed nor pinched; costa precurrent or shortly excurrent . . . . . *Desmatodon*
82. Excurrent awn serrate, awn a third or more the length of lamina; leaves when moist squarrose-recurved . . . . . *Tortula*
82. Excurrent awn smooth to ± dentate, awn a fourth or less the length of lamina; leaves erect spreading when moist . . . . . *Desmatodon*

ANNOTATED LIST WITH KEYS TO THE SPECIES

Acaulon C. Muell. Pottiaceae

1. Costa present from tip to base of leaf; leaves only slightly papillose at back to completely smooth; spores smooth to finely granulate . . . . . 1. *A. muticum*
1. Costa present from tip to mid region but lacking at leaf base; leaves papillose on both sides; spores smooth to finely papillose . . . . . 2. *A. schimperianum*

1. *Acaulon muticum* (Hedw.) C. Muell. In open grassy areas; on soil. Uncommon, but probably overlooked. Presently known only from the central portion of the state.
2. *Acaulon schimperianum* (Sull.) Sull. *ex* Sull. *&* Lesq. In prairies; on partly disturbed soil. Only a single collection known, made by *Smith 2681* (NY!) from Reno County. Rare.

Aloina (C. Muell.) Kindb. Pottiaceae.

1. *Aloina rigida* (Hedw.) Limpr. In High Plains grassland; on calcareous, gypsum and sandstone rock and soil. Based on the collections that I have made both here in Kansas and elsewhere (Churchill, 1979*a*, 1979*b*, 1983) it appears that this species is probably not an uncommon component of the High Plains moss flora. Western half of Kansas.

Amblystegium B.S.G. Amblystegiaceae

1. Median leaf cells linear, often vermicular, averaging 7-15:1 . . . . 1. *A. riparium*
1. Median leaf cells oblong to rhomboidal, averaging less than 7:1 . . . . . 2.
2. Costa noticeably thick, averaging 40 um or more in width at leaf base . . . . . 3. *A. tenax*
2. Costa ± thin, less than 40 um in width at leaf base . . . . . 3.
3. Costa extending into the acuminate leaf tip; cells 1-2 (3):1 . . . . . 5. *A. varium*
3. Costa extending 1/2-3/4 way up the leaf, but not into the acuminate leaf tip; cells 3-5:1 . . . . . 4.
4. Leaf ca. 1.2-2.2 mm long; cells ca. 5:1 . . . . . 4. *A. trichopodium*
4. Leaf ca. 0.5-1 mm long, cells ca. 3:1 . . . . . 2. *A. serpens*

1. *Amblystegium riparium* (Hedw.) B.S.G. *(Leptodictyum)* In woods or marshy areas; most often found on decaying logs or over decaying marsh vegetation, occasionally on soil. C.fr. Occasional. Probably scattered throughout Kansas, particularly the eastern half.
2. *Amblystegium serpens* (Hedw.) B.S.G. *(A. juratzkanum)* In open to closed woods and prairies; found on trees (*Fraxinus pennsylvanica* and *Ulmus* sp.), on decaying logs, on soil, soil covered sandstone rocks, and on decaying marsh vegetation. C.fr. Frequent. Scattered throughout the state.
3. *Amblystegium tenax* (Hedw.) C. Jens. *(Hygroamblystegium tenax* and *A. fluviatile)* Along and in creeks both in woods and prairies; on marsh banks, creek beds, decaying logs but most often found on either limestone or sandstone rocks. C.fr. Common. Throughout Kansas.
4. *Amblystegium trichopodium* (Schultz) Hartm. *(Amblystegium kochii* and *Leptodictyum trichopodium)* In open to closed woods, less common in prairies; on soil, decaying logs and over sandstone rock. C.fr. Occasional. Throughout Kansas.
5. *Amlystegium varium* (Hedw.) Lindb. In open to closed woods, occasional in

prairies; on soil, sandstone rock, decaying logs and trees *(Carya* sp. and *Quercus muhlenbergii).* C.fr. Occasional. Throughout Kansas.

NOTE: Some authors still recognize the ecological genera *Hygroamblystegium* and *Leptodictyum* but these have no phyletic meaning at the generic level. The *Amblystegium* species that one finds in the Plains region exhibit a wide range of phenotypic variation of the gametophyte. Experimental laboratory work and biometrical analysis of this genus would be most worthwhile. The many species, varieties and forms that have been named in the past are certainly only environmental variants not worthy of nomenclatural status.

Anomobryum Schimp. Bryaceae

1. *Anomobryum filiforme* (Dicks.) Solms. In open woods; on sandstone boulder. Rare. Known only from Woodson County (Churchill, 1979*b*). This minute species should be sought in other open *Quercus* wooded sandstone sites.

Anomodon Hook. & Tayl. Thuidiaceae

1. Leaf tip with hyaline point, tip acuminate . . . . . 3. *A rostratus*
1. Leaf tip lacking a hyaline point, tip obtuse or acute . . . . . 2.
2. Leaf tip rounded to obtuse . . . . . 2. *A. minor*
2. Leaf tip acute . . . . . 1. *A. attenuatus*

1. *Anomodon attenuatus* (Hedw.) Hueb. In woods; on moist to dry soil, limestone and sandstone rock. C.fr. Common. Eastern half of Kansas.
2. *Anomodon minor* (Hedw.) Fuernr. In woods; on moist to dry soil, limestone rock, and base of trees (including *Carya* sp., *Quercus macrocarpa* and *Ulmus americana*). C.fr. Very common. Eastern half of Kansas.
3. *Anomodon rostratus* (Hedw.) Schimp. In woods; on moist to dry soil, on limestone and sandstone rocks, and base of trees. Rare c.fr. Common. Eastern half of Kansas.

Archidium Brid. Archidiaceae

1. *Archidium ohioense* Schimp. *ex* C. Meull. Exposed in open woods and prairies; on sandy and alluvial soils. C.fr. Rare? Probably more common but overlooked. South-central Kansas.

Aschisma Lindb. Pottiaceae

1. *Aschisma kansanum* Andr. In High Plains grassland; on exposed knolls, confined to edge of clear or white quartz pebbles that are usually 2-5 cm in diameter. C.fr. Rare. Endemic to the Plains, at present known only from south central Kansas but should be sought in Oklahoma and Colorado. See discussion under Kansas types. If any moss should be placed on a "threatened or endangered" list for mosses of the United States, this species surely qualifies.

Astomum Hampe Pottiaceae

1. Seta much shorter than the capsule . . . . . 1. *A. muhlenbergianum*
1. Seta as long or longer than the capsule . . . . . 2. *A. phascoides*

1. *Astomum muhlenbergianum* (Sw.) Grout Exposed to shaded, most often in prairies, occasionally in open woods; on soil or sandstone rock. C.fr. Common. Throughout Kansas. Often associated with *Weissia controversa* with which it is known to hybridize freely; I have seen a few collections from mixed

populations where some of the capsules were poorly developed suggesting hybrid forms. An excellent summary and study is presented by Anderson and Lemmon (1972) concerning hybridization among these taxa.

2. *Astomum phascoides* (Hook. *ex* Drumm.) Grout In open disturbed areas and prairies; on soil. C.fr. Rare?

NOTE: One other *Astomum* has been previously reported: *A. ludovicianum* Sull. (Smith, 1966).

Atrichum P.-Beauv. Polytrichaceae

1. Upper leaf cells averaging 12-17 um in longest dimension; middle stem leaves mostly 1 mm or less wide; dioicous . . . . . 1. *A. angustatum*
1. Upper leaf cells averaging 17 um or more in longest dimension; stem leaves usually wider than 1 mm; autoicous or dioicous . . . . . 2. *A. undulatum*

1. *Atrichum angustatum* (Brid.) B.S.G. In woods, occasionally in prairies; on moist to dry soil, sandy soil, and thin soil over sandstone rock. C.fr. Common. Eastern half of Kansas.
2. *Atrichum undulatum* (Hedw.) P.-Beauv. In Kansas there are two recognized species of this complex:
   A. altecristatum (Ren. & Card.) Smyth & Smyth. Lamellae averaging 4-6 cells high; plants autoicous; stem lacking whitish rhizoids. Reported by Ireland (1969*a*). Uncommon. Probably to be found in the eastern third of Kansas.
   A. oerstedianum (C. Muell.) Mitt. Lamellae 2-4 cells high (up to 8); plants dioicous; stems clothed with whitish rhizoids. Reported by Churchill (1980) for Douglas County.

NOTE: If the appropriate characters are present, one can readily identify these various taxa in the *Atrichum undulatum* complex. However, if plants are sterile or have a variable number of lamellae cells, then it may be best to simply recognize this as a complex for floristic purposes while realizing that these are very likely both good evolutionary and biological species. Certainly detailed cytological, morphological and chemical work is needed for this interesting genus. Reference: Ireland (1969*a*).

Aulacomnium Schwaegr. Aulacomniaceae

1. Leaf tip rounded to obtuse; margins plane; cells smooth . . . 1. *A. heterostichum*
1. Leaf tip acute; margins revolute; cells unipapillose . . . . . 2. *A. palustre*

1. *Aulacomnium heterostichum* (Hedw.) B.S.G. In woods; on moist soil, and thin soil over sandstone rock, often encountered on bank slopes. C.fr. Occasional. Eastern third of Kansas. Some of our plants exhibit the small deciduous leaves at the stem tip which may function as propagula analogous to the propagula commonly associated with *A. palustre* (see discussion by Lowry and Steere, 1946).
2. *Aulacomnium palustre* (Hedw.) Schwaegr. In marshes, around seepage areas or border of ponds. Propagula present. Uncommon. Eastern half of Kansas. The report by Smith (1966) of *Dichodontium pellucidum* is this taxon.

Barbula Hedw. Pottiaceae

1. Leaves oblong-lanceolate; obtuse-acute and apiculate . . . . . 2.
1. Leaves lanceolate to subulate, from a broad to ovate base; acuminate. . . . . 3.
   2. Propagula present . . . . . 3. *B. indica*
   2. Propagula absent . . . . . 4. *B. unguiculata*

3. Leaves with a costa precurrent, costa ending below the apex . . . . . 2. *B. fallax*
3. Leaves with a costa excurrent, extending distinctly beyond the leaf . . . . . 1. *B. acuta*

1. *Barbula acuta* (Brid.) Brid. In prairies and plains; on sandy soil and calcareous rock. Common. Western half of Kansas. See notes under *Didymodon rigidulus.*
2. *Barbula fallax* Hedw. In prairies and open woods; on clay or sandy soil, often of disturbed sites. Uncommon. Eastern third of Kansas.
3. *Barbula indica* (Hook.) Spreng. *(B. cancellata* and *B. cruegeri)* In open woods; on sandstone rock. Propagula present. Uncommon. Eastern third of Kansas.
4. *Barbula unguiculata* Hedw. In open woods, prairies and disturbed areas; on soil, sand dunes, and limestone rock. C.fr. Common. Throughout Kansas.

Bartramia Hedw. Bartramiaceae

1. *Bartramia pomiformis* Hedw. In woods; on moist soil and soil over sandstone rock, often on hill slopes. C.fr. Occasional. Eastern third of Kansas.

Brachythecium B.S.G. Brachytheciaceae

1. Stem leaves ca. 2 mm long, distinctly plicate; alar cells subquadrate, not forming a distinct compact group of small cells . . . . . 3. *B. oxycladon*
1. Stem leaves ca. 1.5 mm long or shorter, plication indistinct; alar cells quadrate, forming a small distinct group of cells . . . . . 2.
   2. Leaves subjulaceous; plants dioicous; often found on tree trunks; eastern Kansas . . . . . 1. *B. acuminatum*
   2. Leaves ± spreading, or leaf tips ± curved; plants autoicous; on calcareous soil and rock; western Kansas . . . . . 2. *B. collinum*

1. *Brachythecium acuminatum* (Hedw.) Aust. *(Chamberlainia)* In open to closed woods; occasionally on soil or thin soil over limestone, but most often encountered on base trunk of trees and shrubs (including *Quercus muehlenbergii* and *Ribes missouriense!*), also on decaying tree stumps. Occasional. Eastern half of Kansas.
2. *Brachythecium collinum* (Schleich. *ex* C. Muell.) B.S.G. In High Plains; on calcareous soil and rock. Rare? Originally this was determined as *Brachythecium salebrosum* by Smith (1966) based on *Smith 1944* (NY) from Cheyenne County. The distribution reported for Nebraska (Churchill, 1979*a*) would suggest that this species may be found in additional sites in western Kansas.
3. *Brachythecium oxycladon* (Brid.) Jaeg. & Sauerb. *(Chamberlainia)* In open to closed woods, occasional in prairies; on moist to dry soil, on thin soil over limestone and sandstone rock, and on decaying logs. C.fr. Very common. Eastern three-fourths of Kansas. The reports by McGregor (1950) and Smith (1966) of *Brachythecium salebrosum* (Web. & Mohr) B.S.G. and/or *B. calcareum* Kindb. are *B. oxycladon.*

Bruchia Schwaegr. Dicranaceae

1. Spores pitted, up to 27 um wide; seta mostly immersed, shorter than the capsule . . . . . 1. *B. brevifolia*
1. Spores spinuose or reticulate, up to 40 um wide; seta often as long or longer than the capsule . . . . . 2.
   2. Spores spinose, up to 40 um wide; awn smooth . . . . . 2. *B. flexuosa*
   2. Spores reticulate, up to 45 um wide; awn rough. . . . . 3. *B. texana*

1. *Bruchia brevifolia* Sull. In prairies; on sand dunes. C.fr. Rare? Known only from Reno County.
2. *Bruchia flexuosa* (Sw. *ex* Schwaegr.) C. Meull. Old crop fields; on bare exposed soil. C.fr. Rare? Known only from Douglas County.
3. *Bruchia texana* Aust. Open areas; on dry sandy soil. C.fr. Rare? Known only from Wilson County.

NOTE: It is essential that spores be used for identification of the *Bruchia* species. The distribution maps suggest a rare occurrence for all *Bruchia* taxa but it is more likely that these minute species, never over a few millimeters tall, are simply overlooked. Reference: Britton, 1913.

Bryhnia Kaur. Brachytheciaceae

1. *Bryhnia graminicolor* (Brid.) Grout. In woods; on moist soil bank and soil over sandstone rock. Occasional. Eastern third of Kansas.

Bryoandersonia Robins. Brachytheciaceae

1. *Bryoandersonia illecebra* (Hedw.) Robins. In woods; soil over sandstone and on shaded bank. This species is frequently found in southern Missouri (Redfearn, 1972) and eastern Oklahoma (Churchill et al., 1981). Recently reported as a new state record for Kansas (Churchill, 1982), this species should be sought elsewhere in eastern Kansas, particularly the wooded sandstone sites.

Bryum Hedw. Bryaceae

1. Plants julaceous, appearing whitish-silver; lacking a distinct marginal border . . . . . 1. *B. argenteum*
1. Plants not julaceous, light to dark green occasionally appearing bleached; marginal border usually distinct . . . . . 2.
2. Plants with abundant filiform brood-bodies in leaf axil; costa precurrent . . . . . 3. *B. capillare*
2. Plants lacking filiform brood-bodies; costa precurrent or excurrent . . . . . 3.
3. Costa distinctly excurrent . . . . . 4.
3. Costa precurrent or indistinctly excurrent . . . . . 6.
4. Plants dioicous . . . . . 4. *B. caespiticium*
4. Plants synoicous . . . . . 5.
5. Cilia lacking, endostome poorly developed, lower half adhering to exostome . . . . . 1. *B. algovicum*
5. Cilia appendiculate, endostome well developed, and not adhering to exostome . . . . . 6. *B. creberrimum*
6. Leaf apex obtuse-rounded; marginal border indistinct; distinct serrulation lacking . . . . . 5. *B. gemmiparum*
6. Leaf apex acute-acuminate; marginal border distinct; serrulation confined to apex . . . . . 7.
7. Leaf ca. 1 mm long, base not decurrent (axillary bulbiform gemmae sometimes present) . . . . . 3. *B. bicolor*
7. Leaf ca. 2-2.5 mm long, base decurrent (gemmae absent) . . . . . 8. *B. pseudotriquetrum*

1. *Bryum algovicum* Sendtn. *ex* C. Muell. *(B. angustirete* and *B. pendulum)* In open woods and prairies; on sandstone rock. C.fr. Uncommon. Scattered throughout Kansas.

2. *Bryum argenteum* Hedw. In natural and disturbed areas in most habitats, usually uncommon in shaded woods; on soil. C.fr. Common. Throughout Kansas.
3. *Bryum bicolor* Dicks. In prairies; on soil and thin soil over sandstone. Bulbiform gemmae often present. Uncommon. Probably scattered throughout Kansas, particularly the eastern half.
4. *Bryum caespiticium* Hedw. In natural and disturbed areas of prairies, open to closed woods, and less common in the plains; on soil, on thin soil over sandstone and limestone. C.fr. Frequent. Scattered throughout Kansas.
5. *Bryum capillare* Hedw. In prairies; on sandstone rock in ravines. Known only from Ellsworth County based on *Smith 1297* (NY!). Brood bodies present.
6. *Bryum creberrimum* Tayl. *(B. cuspidatum)* In woods, prairies and plains; on soil and soil over rock. C.fr. Occasional. Scattered throughout Kansas.
7. *Bryum gemmiparum* De Not. In High Plains; on calcareous soil and rock of seepage sites. Uncommon. Western half of Kansas.
8. *Bryum pseudotriquetrum* (Hedw.) Gaertn., Meyer & Scherb. Open woods, upland prairie springs and disturbed sites; most often found on thin soil over sandstone rock, occasionally on sandy soil. Occasional. Eastern half of Kansas.

NOTE: *Bryum* is a difficult genus and if sterile, identification is quite impossible for some species—particularly *B. algovicium, B. caespiticium* and *B. creberrimum.* For mapping the Kansas *Bryum*'s, sexual condition and gametophytic features were used in combination when sporophytic capsules were lacking. Specimens lacking capsules or sexual features were not mapped for the taxa mentioned above.

Campylium (Sull.) Mitt. Amblystegiaceae

1. Leaf with single costa extending half or somewhat farther to apex . . . . . 1. *C. chrysophyllum*
1. Leaf with very short, usually double costa extending a fourth to fifth way from base . . . . . 2. *C. hispidulum*

1. *Campylium chrysophyllum* (Brid.) J. Lange. In prairies and woods; on moist to dry soil, on loam and sandy soil, thin soil over sandstone rock. Frequent. Eastern half of Kansas.
2. *Campylium hispidulum* (Brid.) Mitt. In prairies, plains and woods; moist to damp soil, often in calcareous and sandstone areas under rock ledges and crevices, and at base of trees. Frequent. Throughout Kansas.

Ceratodon Brid. Ditrichaceae

1. *Ceratodon purpureus* (Hedw.) Brid. In prairies and open woods, especially disturbed or exposed sites; on sandy to loam soil. C.fr. Occasional. Throughout Kansas.

Climacium Web. & Mohr Climaciaceae

1. *Climacium americanum* Brid. Open to closed woods; marsh areas along tributaries and wooded slopes, most often over sandstone rock. Uncommon. Eastern third of Kansas.

Desmatodon Brid. Pottiaceae

1. Leaves with a distinct light border of cells, papillae lacking or nearly so along margin; leaf apex acute . . . . . 3. *D. porteri*

1. Leaves without a distinct border of differentiated cells, all cells appearing papillose along margin; leaf apex obtuse-rounded or with a long hyaline awn . . . . . 2.
   2. Leaves with a hyaline awn, greater than 0.5 mm and usually up to 1 mm . . . . . 2. *D. plinthobius*
   2. Leaves lacking a distinct awn, occasionally with a short apiculate or hyaline mucro tip, less than 0.5 mm long . . . . . 1. *D. obtusifolius*

1. *Desmatodon obtusifolius* (Schwaegr.) Schimp. In woods and prairies; usually found on sandstone rock, less common on calcareous rock. C.fr. Common. Throughout Kansas.
2. *Desmatodon plinthobius* Sull. & Lesq. *ex* Sull. In open woods, less common in prairies; on calcareous and sandstone rocks. C.fr. Common. Throughout Kansas.
3. *Desmatodon porteri* James. In woods; on sandstone. C.fr. Rare? Eastern third of Kansas. Many of the collections made by Smith (1961) and identified under this name are in fact *Desmatodon obtusifolius.*

NOTE: Conard (1951) noted the occasional occurrence in which *Desmatodon obtusifolius* has a short awn; a few collections from Kansas also exhibit this feature, but can be separated by the length of the awn and the collenchymatus submedian cells that are lacking in *D. plinthobius.*

Dicranella (C. Muell.) Schimp. Dicranaceae

1. Seta yellow; capsule plicate (when empty); leaves usually falcate-secund; margins serrulate from the tip to beyond the leaf middle; margins plane . . . . . 1. *D. heteromalla*
1. Seta red-brown; capsule smooth (when empty); leaves erect to slightly spreading; mostly entire; margins recurved . . . . . 2. *D. varia*

1. *Dicranella heteromalla* (Hedw.) Schimp. In open to closed woods; on sandy soil, soil over sandstone rock, and riparian banks. C.fr. Occasional. Eastern half of Kansas.
2. *Dicranella varia* (Hedw.) Schimp. In open to closed woods, wooded margins, often of disturbed sites; sandy or clay soils, occasionally found on sandy soil over standstone rock. C.fr. Occasional. Eastern third of Kansas.

Dicranum Hedw. Dicranaceae

1. Upper leaf cells quadrate to rectangular, 1-2:1 . . . . . 1. *D. condensatum*
1. Upper leaf cells elongate, ± porose, 5:1 . . . . . 2. *D. scoparium*

1. *Dicranum condensatum* Hedw. *(D. sabuletorum)* In woods; on sandy soil, and soil over sandstone rock. C.fr. Uncommon. Eastern third of Kansas. Given the recent discovery of this taxon by the author in Douglas County and the reports given by Smith (1961), this should be sought in other slightly xerophytic open wooded sites with sandstone substrate in eastern Kansas.
2. *Dicranum scoparium* Hedw. In woods; often in cushions over sandstone rock or on sandy soil banks. C.fr. Frequent. Eastern third of Kansas.

Didymodon Hedw. Pottiaceae

1. Leaves strongly decurrent; axillary gemmae absent; mesic or aquatic sites. . . . . 2. *D. tophaceus*

1. Leaves not noticeably decurrent; axillary gemmae present; xeric sites. . . . . 1. *D. rigidulus*

1. *Didymodon rigidulus* Hedw. In plains and prairies; on gravel or calcareous soil and on calcareous or sandstone rock. Axiallary gemmae present. Common. Western half of Kansas. Both *Didymodon rigidulus* and *Barbula acuta* are equally encountered in western Kansas, and may be confused. *Barbula acuta* has leaves that are squarrose-spreading when wet, the costa typically extends well beyond the lamina, and lacks gemmae; *Didymodon rigidulus* has erect-patent leaves when wet, precurrent costa, and axillary gemmae. Many of the collections made and reported on by Smith (1966) of *Didymodon rigidulus* are in fact *Barbula acuta* (NY!).
2. *Didymodon tophaceus* (Brid.) Lisa. In spring and marsh sites; often on calcareous substrates of soil and rock. Occasional. Scattered throughout Kansas. The distinctive long decurrent leaves is a diagnostic feature found in no other Pottiaceae moss in Kansas.

Diphyscium Mohr Buxbaumiaceae

1. *Diphyscium foliosum* (Hedw.) Mohr. In open to closed woods; on sandstone rock. C.fr. Rare. Known only from Douglas and Woodson counties.

Ditrichum Hampe Ditrichaceae

1. *Ditrichum pallidum* (Hedw.) Hampe. In open to closed woods, disturbed prairies and roadsides; on soil, often on sandy soil or thin soil over sandstone rock. C.fr. Common. Eastern half of Kansas. The long yellow seta and subulate leaves are diagnostic.

Drepanocladus (C. Muell.) Roth. Amblystegiaceae

1. *Drepanocladus aduncus* (Hedw.) Warnst. In exposed wet areas, ponds, stream banks, marshes etc. Uncommon. North central Kansas.

Drummondia Hook. Orthotrichaceae

1. *Drummondia prorepens* (Hedw.) Britt. In woods; usually on upper trunk of trees (including *Quercus*). C.fr. Occasional. Southeastern Kansas.

Entodon C. Muell. Entodontaceae

1. Leaves julaceous; quadrate alar cells more than 10 along the margin; peristome smooth . . . . . 3. *E. seductrix*
1. Leaves complanate; quadrate alar cells 10 or fewer along the margin; peristome various. . . . . 2.
   2. Leaf length 1(1.5) mm; width of leafy branch ca. 1(1.5) mm; peristome papillose . . . . . 1. *E. compressus*
   2. Leaf length (1.5)2 mm; width of leafy branch ca. 2 mm; peristome smooth . . . . . 2. *E. cladorrhizans*

1. *Entodon compressus* C. Muell. *(E. challengeri)* In woods; on base trunk of trees (including *Celtis occidentalis, Quercus macrocarpa* and *Q. muehlenbergii*), occasionally decaying logs, rarely on soil. C.fr. Frequent. Eastern half of Kansas.
2. *Entodon cladorrhizans* (Hedw.) C. Muell. In woods; on trees, decaying logs, and over limestone. Uncommon. Eastern third of Kansas.
3. *Entodon seductrix* (Hedw.) C. Muell. In open to closed woods, rarely in sandstone prairies; on moist to dry soil, sandstone and limestone, decaying

logs, base trunk of trees (including *Fraxinus* sp. and *Quercus muehlenbergii*). C.fr. Common. Eastern half of Kansas.

Ephemerum Hampe Ephemeraceae

1. Cells in the middle third of leaf smooth, in diagonal rows from the costa to margin . . . . . 1. *E. cohaerens*
1. Cells of the leaf papillose above or if smooth then cells not in diagonal rows . . . . . 2.
   2. Upper leaves spinose, teeth mostly recurved at an angle of 45° or more; leaves usually narrowly linear-lanceolate; median cells 4-8:1 . . . . . 3. *E. spinulosum*
   2. Upper leaves entire to strongly toothed, teeth at an angle of less than 45°; median cells less than 4:1 . . . . . 2. *E. crassinervium*

1. *Ephemerum cohaerens* (Hedw.) Hampe. In woods and prairies; on soil, often on exposed or disturbed soil. C.fr. Occasional. Eastern half of Kansas.
2. *Ephemerum crassinervium* (Schwaegr.) Hampe. In prairies; on sandy soil. C.fr. Rare. Known only from Reno County.
3. *Ephemerum spinulosum* Bruch & Schimp. *ex* Schimp. In prairies and sand dune areas; on sandy soil, also soil over limestone rock. C.fr. Uncommon. Central; expected in eastern Kansas.

Reference: Bryan & Anderson (1957).

Eucladium B.S.G. Pottiaceae

1. *Eucladium verticillatum* (Brid.) B.S.G. Shaded in woods; on wet to moist limestone rock; often associated with *Fissidens*. Uncommon. Southeast Kansas.

Eurhynchium B.S.G. Brachytheciaceae

1. Branch leaves ovate, acute; seta rough . . . . . 1. *E. hians*
1. Branch leaves narrowly ovate to lanceolate, acutely blunt to obtuse; seta smooth . . . . . 2. *E. pulchellum*

1. *Eurhynchium hians* (Hedw.) Sande Lac. In woods or margin of woods, often in disturbed sites; on moist soil. C.fr. Frequent. Eastern half of Kansas.
2. *Eurhynchium pulchellum* (Hedw.) Jenn. In open woods; on moist soil, and thin soil over sandstone rock. Occasional. Eastern half of Kansas.

Fabronia Raddi Fabroniaceae

1. *Fabronia ciliaris* (Brid.) Brid. *(F. imperfecta)* In woods; lower and more often upper tree trunks (including *Celtis occidentalis, Juglans nigra, Quercus* spp., and *Ulmus* sp.). C.fr. Frequent. Eastern half of Kansas. Past reports (McGregor, 1950) of *F. wrightii* Sull. are *F. ciliaris*.

Fissidens Hedw. Fissidentaceae

1. Plants aquatic; leaves linear-lanceolate; vaginant lamina extending only a fourth to third the way up the lamina . . . . . 3. *F. fontanus*
1. Plants not aquatic, but often on moist or wet substrates; leaves various shapes but not linear; vaginant lamina extending to about half the way up the lamina . . . . . 2.
   2. Leaves distinctly obtuse-rounded . . . . . 5. *F. obtusifolius*
   2. Leaves acute . . . . . 3.

3. Leaves with a distinct border of linear cells extending beyond the middle to near the apex . . . . . 1. *F. bryoides*
3. Leaves lacking a border made up of linear cells extending beyond the middle . . . . . 4.
4. Leaves with a border of linear cells at the base, plants less than 5 mm tall . . . . . 4. *F. garberi*
4. Leaves lacking border of linear cells; plants mostly greater than 5 mm tall . . . . . 5.
5. Leaves regular, finely crenulate-serrulate . . . . . 7. *F. taxifolius*
5. Leaves irregularly dentate, serrulate or crenulate-serrate . . . . . 6.
6. Costa ending several cells below the apex, costa cells mammillose . . . . . 6. *F. subbasilaris*
6. Costa percurrent (extending into the apex), costa cells not mammillose . . . . . 2. *F. cristatus*

1. *Fissidens bryoides* Hedw. *(F. minutulus, F. sublimbatus* and *F. viridulus)* In woods and plains; on calcareous and sandstone rocks, usually in crevices or over-hanging ledges, occasionally found on sandy or loam soil especially on stream banks. C.fr. Frequent. Scattered throughout Kansas.
2. *Fissidens cristatus* Wils. *ex* Mitt. Open to closed woods and in prairies; on sandstone rock or sandy soil over sandstone, occasionally on loam soil banks. C.fr. Occasional. Eastern half of Kansas.
3. *Fissidens fontanus* (B.-Pyl.) Steud. *(F. debilis* and *F. julianus)* In woods or sandstone prairies; aquatic, attached to rocks or occasionally to twigs and branches of trees in streams. Uncommon. Eastern half of Kansas.
4. *Fissidens garberi* Lesq. & James. In woods; on moist sandstone rock. Rare. Known only from Woodson County.
5. *Fissidens obtusifolius* Wils. Open woods and prairies; on moist calcareous or sandstone rocks, usually found in crevices or under over-hanging ledges. C.fr. Occasional. Scattered throughout Kansas. Two forms of this taxon occur in Kansas: var. *obtusifolius* has quadrate cells at base of leaf, whereas var. *kansanus* Ren. & Card. has linear cells along the leaf base margin. This latter taxon is confined to central and southwestern North America whereas the typical form is found in eastern and western North America. The report by Smith (1966) of *F. osmundioides* Hedw. belongs to *F. obtusifolius.*
6. *Fissidens subbasilaris* Hedw. In woods; on rock, soil or base trunk of trees. Uncommon. Eastern third of Kansas. The report by McGregor (1950) of *F. bushii* (Card. & Ther.) Card. & Ther. is *F. subbasilaris.*
7. *Fissidens taxifolius* Hedw. In woods; on soil banks, often on clay soil. Occasional. Eastern third of Kansas.

Fontinalis Hedw. Fontinalaceae

1. *Fontinalis missourica* Card. Submerged in streams; attached to rocks. Rare. The last known collection of this taxon was made by Grace Meeker in 1900 from Middle Creek in Franklin County. Several other collections from that county are dated 1892 and 1894. The type locality for this taxon is in nearby Benton County, Missouri. See Welch (1960) for further discussion.

Funaria Hedw. Funariaceae

1. Capsule only slightly bent, smooth, constricted just below mouth; annulus

absent . . . . . 1. *F. americana*

1. Capsule bent or inclined, usually grooved or ribbed, lacking a constriction below mouth; annulus present. . . . . 2.
   2. Leaves acuminate with the costa excurrent; inner peristome blunt, ca. half the length of outer peristome; spores rough, 20-50 um wide . . 2. *F. flavicans*
   2. Leaves acute (or shortly acuminate) with the costa percurrent; inner peristome nearly equal to the outer; spores smooth, 14-17 um wide . . . . . 3. *F. hygrometrica*

1. *Funaria americana* Lindb. In prairies; on sandstone rock, or thin soil over sandstone. C.fr. Uncommon. Central Kansas. Smith (1980) has characterized this species as a strict calciphile with a Pleistocene or post-Pleistocene distribution. The distribution map is based in part on Smith (1980).
2. *Funaria flavicans* Michx. In open woods and prairies, often in disturbed sites; on soil, often sandy. C.fr. Common. Eastern half of Kansas.
3. *Funaria hygrometrica* Hedw. In woods and prairies, often in disturbed and burnt areas, e.g. roadsides etc.; on soil, occasionally rocky or sandy substrates. C.fr. Frequent. Throughout Kansas.

Grimmia Hedw. Grimmiaceae

1. Leaves flat to slightly concave in section, not keeled; margins plane, not recurved . . . . . 2.
1. Leaves keeled in cross-section (in upper half); margins ± recurved . . . . . 3.
   2. Leaves unistratose in section; hyaline awn denticulate; seta sigmoid; capsule gibbous, immersed among leaves . . . . . 2. *G. plagiopodia*
   2. Leaves bistratose; hyaline awn spinulose; seta straight; capsule symmetrical, exserted slightly beyond the leaves . . . . . 1. *G. laevigata*
3. Upper leaves with a long hyaline awn; central strand of stem well defined; capsule often present . . . . . 3. *G. pulvinata*
3. Upper leaves with a muticous tip or a very short spinulose awn; central strand of stem poorly defined; capsule unknown . . . . . 4. *G. teretinervis*

1. *Grimmia laevigata* (Brid.) Brid. In open to closed woods, occasionally in prairie transition from woods, or in prairies; most often on sandstone, found once on limestone. Rare c.fr. Frequent. Eastern two-thirds of Kansas.
2. *Grimmia plagiopodia* Hedw. In prairies; exposed on sandstone. C.fr. Rare? Known only from Ellsworth County. This taxon should be sought in other sandstone or calcareous sites in western Kansas.
3. *Grimmia pulvinata* (Hedw.) Sm. In open woods and prairies; on sandstone. C.fr. Occasional. The plants reported by McGregor and Hartman (1956) of *G. olneyi* Sull. is this taxon. Central and southeast Kansas.
4. *Grimmia teretinervis* Limpr. In plains; on exposed calcareous rocks. Uncommon. West central Kansas.

Haplocladium (C. Muell.) C. Muell. Thuidiaceae

1. Stem leaves broadly ovate to rounded, tip short acuminate; branch leaves acute rounded; leaves not plicate (or if so, indistinct); upper margin ± dentate to entire . . . . . 2. *H. virginianum*
1. Stem leaves lanceolate, broad at base, tip ± long acuminate; branch leaves also acuminate; leaves usually plicate; upper margins sinuate-serrulate . . . . . 1. *H. microphyllum*

1. *Haplocladium microphyllum* (Hedw.) Broth. *(Thuidium)* In woods and adjoining prairies; on soil, often sandy, trunk of trees, and decaying logs. Occasional. Eastern half of Kansas.
2. *Haplocladium virginianum* (Brid.) Lindb. *(Thuidium)* In woods; on soil and bark of trees (including *Ulmus* sp.). Uncommon. Eastern third of Kansas.

Hedwigia P.-Beauv. Hedwigiaceae

1. *Hedwigia ciliata* (Hedw.) P.-Beauv. In woods and prairies; on limestone and sandstone. C.fr. Frequent. Eastern half of Kansas.

Homomallium (Schimp.) Loeske Hypnaceae

1. *Homomallium adnatum* (Hedw.) Broth. In woods and prairies; on limestone and sandstone, rarely on bark of trees. C.fr. Common. Eastern half of Kansas. The report of *Homomallium mexicanum* Card. by Smith (1966) is *Hypnum vaucheri* Lesq.

Hyophila Brid. Pottiaceae

1. *Hyophila involuta* (Hook.) Jaeg. & Sauerb. *(H. tortula)* In woods; on limestone. Brood bodies present. Rare. Probably to be found in the eastern half of Kansas. This species is often associated with *Fissidens,* especially *F. bryoides,* and may be overlooked among such collections. Cridland (1960) reported collections from Douglas and Woodson counties.

Hypnum Hedw. Hypnaceae

1. Leaves with many small quadrate alar cells; median cells short (ca. 5-7:1); western Kansas . . . . . 3. *H. vaucheri*
1. Leaves with few to several large inflated alar cells; median leaf cells longer (greater than 10:1); eastern Kansas . . . . . 2.
   2. Stem cortex with an outer hyaline layer of cells, larger and thinner than the next inner series . . . . . 2. *H. lindbergii*
   2. Stem cortical cells small, thick and usually golden or dark yellow in color, not hyaline . . . . . 1. *H. curvifolium*

1. *Hypnum curvifolium* Hedw. In woods; on thin soil over sandstone rock. Occasional. Eastern third of Kansas. The report of *Brotherella recurvans* (Michx.) Fleisch. by McGregor & Hartman (1956) in this taxon.
2. *Hypnum lindbergii* Mitt. *(H. patientiae)* In marshy areas; on wet soil or decaying vegetation. Uncommon. Eastern third of Kansas.
3. *Hypnum vaucheri* Lesq. In plains, usually associated with rock outcrops; on soil or rock, mostly calcareous substrate. Occasional. Western half of Kansas. The report of *H. cupressiforme* Hedw. by Smith (1966) belongs to this taxon. With the recent work of Ando (1976) it now is clear that *Hypnum vaucheri* is the common *Hypnum* of the arid plains, whereas *H. cupressiforme* is known only from the mesic Black Hills of South Dakota within the Plains states (Churchill, unpubl. data).

Jaffueliobryum Thér. Grimmiaceae

1. Costa inconspicuous; leaves broadly ovate with upper lamina rounded; lower leaves on plant appressed . . . . . 2. *J. wrightii*
1. Costa conspicuous, raised above the lamina surface; leaves ovate-lanceolate, upper lamina acute-acuminate; lower leaves spreading . . . . . 1. *J. raui*

1. *Jaffueliobryum raui* (Aust.) Thér. *(Grimmia, Coscinodon)* In plains and prairies; on calcareous and sandstone rock. C.fr. Frequent. Western two-thirds of Kansas.
2. *Jaffueliobryum wrightii* (Sull. *in* Gray) Thér. *(Grimmia, Coscinodon)* Location and habitat the same as for *Jaffueliobryum raui.* C.fr. Frequent.

NOTE: These two species occasionally occur together, but can be easily separated in the field by the distinctly julaceous branches of *J. wrightii* as opposed to the patent or spreading leafy branches of *J. raui.* Reference: Churchill (unpubl. data).

Leptobryum (B.S.G.) Wils. Bryaceae

1. *Leptobryum pyriforme* (Hedw.) Wils. In woods; on moist soil, sandstone and at base of trees *(Salix).* C.fr. Occasional. Eastern half of Kansas.

Leskea Hedw. Leskeaceae

1. *Leskea gracilescens* Hedw. In open to closed woods; on soil, limestone and sandstone, decaying logs, but most often found on trees (including *Acer negundo, Carya* sp., *Celtis occidentalis, Fraxinus pennsylvanica, Gleditsia triacanthos, Juglans nigra, Juniperus virginiana, Maclura pomifera, Quercus macrocarpa, Q. marilandica, Q. muehlenbergii, Q. stellata, Populus deltoides, Ulmus americana,* and *U. rubra*). C.fr. Common. Eastern two-thirds of Kansas.

NOTE: The variability of this taxon often approaches that of two other taxa: *L. obscura* Hedw. and *L. polycarpa* Hedw. Until further work is carried out with this group, in particular a biometric analysis, it seems best to regard this as a complex for the Great Plains region. Nearly all our material from this region is *L. gracilescens* in the strict sense. In Kansas, only *L. obscura* has been reported in addition to *L. gracilescens* (McGregor, 1950). Those wishing to separate their material based on traditional characters may use the following key:

1. Leaf length greater than twice the width . . . . . *L. polycarpa*
1. Leaf length less than twice the width . . . . . 2.
   2. Leaves asymmetrical, not plicate . . . . . *L. obscura*
   2. Leaves symmetrical, biplicate, margins with one or both margins recurved . . . . . *L. gracilescens*

Leucobryum Hampe Leucobryaceae

1. *Leucobryum glaucum* (Hedw.) Ångstr. *ex* Fr. Most often found in woods, rarely in moist uplands of open woods and prairies; in cushions on soil over sandstone. Occasional. Eastern third of Kansas.

NOTE: *Leucobryum albidium* (Brid. *ex* P.-Beauv.) Lindb. was reported by McGregor (1950) but in a later study by Smith (1961) this taxon was not included. A specimen of this taxon could not be located at NY, and is excluded from the Kansas moss flora.

Leucodon Schwaegr. Leucodontaceae

1. *Leucodon julaceus* (Hedw.) Sull. In open to closed woods; on various trees (including *Celtis* sp., *Juglans nigra, Quercus marilandica,* and *Q. stellata).* C.fr. Frequent. Eastern third of Kansas.

NOTE: *Leucodon brachypus* Brid. was listed by Grout (1928-1940; vol. III, part 4: 217-218) for Kansas. There is a specimen at NY!, but I believe that the label information may be incorrect, and therefore the species is tentatively excluded from the flora of Kansas.

Lindbergia Kindb. Leskeaceae

1. *Lindbergia brachyptera* (Mitt.) Kindb. In open to closed woods; on trees (including *Acer saccharum, Quercus muehlenbergii, Quercus* sp., and *Ulmus* sp.), occasionally on bark of fallen trees or decaying logs. This moss is usually found on upper tree trunks in thin, loosely scattered strands. Rare c.fr. Common. Eastern half of Kansas.

Orthotrichum Hedw. Orthotrichaceae

1. Leaves with a distinct hyaline awn . . . . . 1. *O. diaphnum*
1. Leaves lacking a hyaline awn, tip occasionally hyaline-apiculate . . . . . 2.
   2. Capsule smooth, ± lacking ribs; stomata superficial; calyptra naked, smooth . . . . . 3. *O. pusillum*
   2. Capsule ribbed; stomata immersed; calyptra with scattered hairs . . . . . 3.
3. Upper leaf cells averaging 7-12 um wide; leaves bistratose on margin in upper half; plants found on rock. . . . . 4. *O. strangulatum*
3. Upper leaf cells averaging 14-20 um wide; leaves unistratose; plants found on tree trunks. . . . . 2. *O. pumilum*

1. *Orthotrichum diaphanum* Brid. In open woods; on trees (including *Juniperus virginiana* and *Ulmus* sp.). C.fr. Occasional. Central Kansas.
2. *Orthotrichum pumilum* Sw. In woods; on trees (including *Juglans nigra, Maclura pomifera, Quercus* spp. and *Ulmus* spp.), occasionally found on decaying logs. C.fr. Common. Eastern three-fourths of Kansas.
3. *Orthotrichum pusillum* Mitt. In woods; on trees (including *Celtis tenuifolia, Cercis canadensis, Quercus marilandica,* and *Q. velutina*). C.fr. Common. Eastern half of Kansas.
4. *Orthotrichum strangulatum* P.-Beauv. Mostly in open woods; on limestone rock. C.fr. Occasional. Eastern third of Kansas.

NOTE: *Orthotrichum sordidum* Sull. *&.* Lesq. *in* Aust. previously reported by McGregor (1950) for Kansas in *O. pusillum* according to Vitt (1973). A duplicate collection of that cited by McGregor (1950) (*Holland 93* in KSC!) contains both *O. pumilum* and *O. pusillum.* Reference: Vitt (1973).

Phascum Hedw. Pottiaceae

1. *Phascum cuspidatum* Hedw. In open woods, prairies and plains; on soil, often sandy. C.fr. Frequent. Throughout Kansas.

Philonotis Brid. Bartramiaceae

1. Leaf cells papillose at the lower end; margin with partly double serration, cell margins concave with extended, pointed ends . . . . . 1. *P. fontana*
1. Leaf cells papillose at upper ends; cell margins pointed only on upper ends, not concave . . . . . 2.
   2. Leaves long triangular-lanceolate, straight or falcate and flat, cells long and narrow (9-15:1), papillae pointed at the extreme upper cell ends; monoicous . . . . . 2. *P. longiseta*
   2. Leaves triangular to slightly ovate-lanceolate, carinate; cells rectangular (less than 9:1); papillae rounded near the upper cell ends; dioicous . . . . . 3. *P. marchica*

1. *Philonotis fontana* (Hedw.) Brid. In springs and marshes; on wet soil over rock. Known only from Leavenworth County.

2. *Philonotis longiseta* (Michx.) Britt. In open to closed woods; on moist to wet soil over sandstone. C.fr. Occasional. Scattered throughout Kansas.
3. *Philonotis marchica* (Hedw.) Brid. In woods; on moist to wet soil on sandstone. C.fr. Occasional. Eastern half of Kansas.

NOTE: The report by Grout (1928-1940) of *Philonotis gracillima* Ångstr. probably refers to Holzinger's Musci Acrocarpii Boreali-Americani No. 71, a collection made by Meeker at Princeton, Kansas; this collection is *P. marchica.* The taxon listed by Grout as *P. glaucescens* (Hornsch.) Broth. is not supported by any known specimen, and is therefore excluded from the flora. Reference: Zales (1976) and correspondence with present author (1979).

Physcomitrium (Brid.) Fuernr. Funariaceae

1. Leaves smooth or slightly dentate in upper half; annulus of 3 layers, revoluble or persistent; spores less than 30 um in diameter. . . . . 2. *P. hookeri*
1. Leaves distinctly dentate or serrate in upper half; annulus 1-2 layers, usually persistent; spores of various sizes, mostly greater than 30 um in diameter . . .
   2. Upper leaves 2 mm or less long; capsule on drying becoming shallow with a very wide, flared mouth; spores 24-37 um in diameter . . . . . 1. *P. collenchymatum*
   2. Upper leaves usually greater than 2.5 mm long; capsule mouth turbinate when dry, not flared; spores ca. 25-50 um in diameter . . . . . 3. *P. pyriforme*

1. *Physcomitrium collenchymatum* Gier. On exposed mud bank along creek. First reported for Kansas by Cridland (1960), this particular taxon was discussed in detail by Crum & Anderson (1964) who included a citation of a specimen at CANM from Douglas County, the only known Kansas locality. Specimen not examined. Distribution map based on Crum & Anderson (1964).
2. *Physcomitrium hookeri* Hampe. In plains and prairies; often in somewhat exposed marshy places, on soil. C.fr. Uncommon. Western two-thirds of Kansas.
3. *Physcomitrium pyriforme* (Hedw.) Hampe. *(P. acuminatum, P. kellermanii,* and *P. turbinatum)* In woods and prairies, often found in disturbed sites including recently burnt areas, roadside ditches and foot paths; on moist soil, occasionally on sandy soil, or over sandstone rock, usually exposed. C.fr. Common. Eastern two-thirds of state.

Plagiomnium T. Kop. Mniaceae

1. Leaf toothed on the margin from near the base to the tip . . . . . 1. *P. ciliare*
1. Leaf toothed on the margin from about the middle to the tip . . . . . 2. *P. cuspidatum*

1. *Plagiomnium ciliare* (C. Muell.) T. Kop. *(Mnium affine* of past reports, and *Mnium ciliare)* In woods; on moist soil and thin soil over sandstone rock. C.fr. Occasional. Eastern third of Kansas.
2. *Plagiomnium cuspidatum* (Hedw.) T. Kop. *(Mnium)* In open to closed woods, rarely in prairies; on moist soil, thin soil over sandstone and limestone rock, on base trunk of trees and over decaying logs. C.fr. Common. Eastern half of Kansas.

NOTE: These two species often occur together, particularly in rich deciduous woods. In addition to the characters listed above, *P. cuspidatum* has obovate leaves

whereas *P. ciliare* has oblong to elliptic leaves. The previous reports of *Mnium affine* (McGregor, 1950, and Magill & Kirkpatrick 1976) are all *Plagiomnium ciliare* (MO! & NY!).

Platygyrium B.S.G. Hypnaceae

1. *Platygyrium repens* (Brid.) B.S.G. In woods; most often found on decaying logs, occasionally on trees (including *Quercus* sp.). C.fr. and axillary brood-branchlets present. Common. Eastern half of Kansas.

Pleuridium Brid. Ditrichaceae

1. *Pleuridium subulatum* (Hedw.) Rabenh. In prairies and margin of woods; exposed on bare soil and on soil among grasses. C.fr. Uncommon? Eastern half of Kansas.

NOTE: *Pleuridium sullivantii* Aust. has been reported from Kansas (McGregor, 1950). This taxon has leaves erect-appressed, imbricate, ovate or mucronate; *P. subulatum* has leaves spreading or secund, lanceolate-subulate (Britton, 1913). No specimen of *Pleuridium sullivantii* could be located at NY and is therefore excluded from the flora until verified.

Pogonatum P.-Beauv. Polytrichaceae

1. Leaves acute to acuminate; 10-15 lamellae on adaxil surface of leaf; margins serrate in upper half of leaf . . . . . 2. *P. pensilvanicum*
1. Leaves ± obtuse; 20-70 lamellae on adaxil surface of leaf; margins entire in upper half of leaf. . . . . 1. *P. brachyphyllum*

1. *Pogonatum brachyphyllum* (Michx.) P.-Beauv. In open woods and prairies; on wet to moist soil over sandstone rock, often found at spring sites. C.fr. Occasional. Eastern half of Kansas. These gregarious plants occur in very thick protonematal sods, a feature that no other Kansas moss shares.
2. *Pogonatum pensilvanicum* (Hedw.) P.-Beauv. In woods; on soil over sandstone. C.fr. Uncommon. Eastern third of state. The report by McGregor & Hartman (1956) of this taxon from Chautauqua County belongs to *P. brachyphyllum* (NY!).

Pohlia Hedw. Bryaceae

1. Median leaf cells 3-5:1; leaves ovate-lanceolate; plant leaves distant, appearing whitish-green with a distinct red stem . . . . . 2. *P. wahlenbergii*
1. Median leaf cells greater than 7:1; leaves lanceolate-acuminate; plant leaves imbricate, shiny golden-green . . . . . 1. *P. nutans*

1. *Pohlia nutans* (Hedw.) Lindb. In open to closed woods; on soil over sandstone, often among cushions of *Leucobryum, Dicranum,* and *Polytrichum.* C.fr. Frequent. Eastern half of Kansas.
2. *Pohlia wahlenbergii* (Web. & Mohr) Andr. In marshes, seepages and spring sites of open woods, prairies, and plains; on decaying marsh vegetation, exposed mud banks, and on thin soil over sandstone rock. Occasional. Scattered throughout Kansas. The leaf shape of *Pohlia wahlenbergii* resembles *Bryum gemmiparum* De Not., but the latter like *Pohlia nutans,* has leaves that are imbricated.

Polytrichastrum G. L. Sm. Polytrichaceae

1. *Polytrichastrum ohionense* (Ren. & Card.) G. L. Sm. *(Polytrichum)* In woods; on

sandy soil or thin soil over sandstone. Uncommon. Eastern third of Kansas. The square marginal cells of the lamellae differentiate this taxon from members of *Polytrichum.*

Polytrichum Hedw. Polytrichaceae

1. Leaves with a distinct hyaline awn . . . . . 3. *P. piliferum*
1. Leaves without a distinct hyaline awn . . . . . 2.
   2. Leaves with marginal teeth; margins not folding over and reaching the middle of the leaf; terminal lamellae cells notched . . . . . 1. *P. commune*
   2. Leaves without teeth; margins folded over and reaching the middle of the leaf; terminal lamellae cells conic . . . . . 2. *P. juniperinum*

1. *Polytrichum commune* Hedw. In woods; in loose to compact cushions over moist sandstone rock. Occasional. Eastern third of Kansas.
2. *Polytrichum juniperinum* Hedw. In woods and occasionally found in upland prairies; usually over sandstone, rarely over limestone, often forming cushions in association with *P. commune.* C.fr. Occasional. Eastern half of Kansas.
3. *Polytrichum piliferum* Hedw. In prairie; on sandy soil. Known from a single collection from Ellsworth County.

Pseudoleskeella Kindb. Leskeaceae

1. *Pseudoleskeella tectorum* (Funck *ex* Brid.) Kindb. *ex* Broth. On calcareous soil in High Plains. Known only from Cheyenne County in extreme northwest Kansas. The report by Smith (1966) of *Amblystegiella subtilis* (Hedw.) Loeske is this taxon (*Smith 1981, 1982,* NY!). The very small leaves and variable costa length or absence of costa are diagnostic. Rare.

Pterygoneurum Jur. Pottiaceae

1. Sporophytes exserted beyond the leaves; seta longer than the capsule; leaves apparent and not obscured by the hyaline awns . . . . . 1. *P. ovatum*
1. Sporophytes immersed to occasionally emergent among the leaves; seta shorter or equal in length to the capsule; leaves obscured by the long hyaline awns . . . . . 2. *P. subsessile*

1. *Pterygoneurum ovatum* (Hedw.) Dix. In plains; on exposed soil in short grassland. C.fr. Rare. Known only from southwest Kansas in Stanton County.
2. *Pterygoneurum subsessile* (Brid.) Jur. In plains and prairies; on calcareous soil among grasses, occasionally found on disturbed soil. C.fr. Frequent. Western half of Kansas.

Ptychomitrium Fuernr. Grimmiaceae

1. *Ptychomitrium incurvum* (Schwaegr.) Sull. In prairies and open *Quercus* upland woods; on sandstone. C.fr. Occasional. Southeast and central Kansas. This species is somewhat similar in aspect to *Weissia* and *Astomum,* but the lobed mitrate calyptra and dark green to black appearance of the gametophyte that lack a mucronate leaf tip help to distinguish this species from the Pottiaceae taxa.

Pylaisiella Kindb. Hypnaceae

1. *Pylaisiella selwynii* (Kindb.) Crum, Steere & Anderson. In woods; on trunks of

trees (including *Celtis occidentalis, Quercus stellata, Populus deltoides,* and *Ulmus* sp.), rarely found on bark of fallen trees. C.fr. Occasional. Eastern half of Kansas.

Pyramidula Brid. Funariaceae

1. *Pyramidula tetragona* (Brid.) Brid. Margin of woods, usually in disturbed sites; on exposed soil, and thin soil over sandstone. C.fr. Uncommon. Eastern third of Kansas.

Rhodobryum (Schimp.) Hampe Bryaceae

1. *Rhodobryum ontariense* (Kindb.) Kindb. (*R. roseum* of past authors) In woods; on soil, usually over sandstone rock. Uncommon. Northeast Kansas.

Rhynchostegiella (B.S.G.) Limpr. Brachytheciaceae

1. *Rhynchostegiella compacta* (C. Muell.) Loeske. *(Amblystegium americanum)* In plains; exposed in marshy springs. Brood bodies present. Uncommon. Western half of Kansas. The report by Smith (1966) of *Brachythecium velutinum* can be referred here (NY!).

Rhynchostegium B.S.G. Brachytheciaceae

1. *Rhynchostegium serrulatum* (Hedw.) Jaeg. & Sauerb. *(Eurhynchium)* In open to closed woods; most often on moist soil, occasionally on base trunk of trees (including *Quercus* sp.), or on decaying logs. C.fr. Frequent. Eastern half of Kansas. The diagnostic features of serrulate margins, twisted leaf tip, and smooth seta aid to distinguish this taxon from *Brachythecium.* The complanate nature of leaves is also found in *Taxiphyllum,* but *Taxiphyllum* lacks the single long leaf costa found in *Rhynchostegium.*

Schistidium Brid. Grimmiaceae

1. Leaves with a distinct hyaline tip; spores about 10 um or less . . . . . 2. *S. apocarpum*
1. Leaves lacking a hyaline tip (ocasionally the perichaetial leaves have a very short hyaline tip); spores usually greater than 10 um . . . . . 1. *S. rivulare*

1. *Schistidium rivulare* (Brid.) Podp. (*Grimmia alpicola* and *Schistidium alpicola,* of recent authors) In open to closed woods, prairies and along transitional tributaries; usually on limestone rock, but also on sandstone. C.fr. Common. Eastern half of Kansas.
2. *Schistidium apocarpum* (Hedw.) B. & S. *in* B.S.G. *(Grimmia apocarpa)* In woods or prairies; on sandstone or limestone rock. C.fr. Uncommon. Eastern half of Kansas. Many of the reports given by McGregor (1950) of *Grimmia apocarpum* are *S. rivulare.*

Reference: Bremer, 1980*a* & 1980*b*.

Sematophyllum Mitt. Sematophyllaceae

1. *Sematophyllum demissum* (Wils.) Mitt. *(S. carolinianum)* In woods; over sloping or vertical sandstone rock. C.fr. Occasional. Eastern third of Kansas. In aspect *Sematophyllum demissum* may be confused with *Homomallium adnatum,* but differs markedly by having a long rostrate operculum and golden-yellow leaves that have slightly inflated alar cells.

Sphagnum L. Sphagnaceae

1. Green cells of branch leaves exposed only or more broadly on the inner

surface of leaf in cross-section . . . . . 1. *S. capillifolium*
1. Green cells of branch leaves exposed only or more broadly on the outer surface of leaf. . . . . 2. *S. cuspidatum*

1. *Sphagnum capillifolium* (Ehrh.) Hedw. *(S. capillaceum* & *S. nemoreum)* Marsh and seepage areas in sandstone prairies and upland woods; wet places among aquatic vascular vegetation and occasionally in seepage over sandstone. Rare. Southeast and central Kansas. The dot map reported herein of *S. nemoreum* should be referred to as *S. capillifolium.*
2. *Sphagnum cuspidatum* Hoffm. *(S. trinitense)* Along margin of old strip mines; in shallow water and wet shore line, among plants of *Scirpus* and *Juncus.* Known only from Cherokee County in southeast Kansas. Both experimental and biometrical studies by Lane (1981) have shown that the taxon *S. trinitense* C. Muell. is only a form of *S. cuspidatum;* the expression of serrulated leaf margins denoting *S. trinitense* appears to be only an environmental modification. Therefore the report of *S. trinitense* (Churchill, 1979*b*) is placed under *S. cuspidatum.* The dot map reported herein of *S. trinitense* should be referred to *S. cuspidatum.*

Taxiphyllum Fleisch. Hypnaceae

1. Leaves imbricate, margins plane or slightly recurved at base; quadrate alar cells 3-8 along marginal row . . . . . 1. *T. deplanatum*
1. Leaves not imbricate (usually distant), margins recurved to at least the middle; cells usually rectangular at base . . . . . 2. *T. taxirameum*

1. *Taxiphyllum deplanatum* (Bruch & Schimp. *ex* Sull.) Fleisch. *(Plagiothecium)* In woods; on forest soil, often on hill slopes and occasionally found on sandstone, rarely on decaying wood or base of trees (including *Juglans nigra*). Occasional. Eastern third of Kansas. Plants of this species generally form a thick distinctive green shiny mat.
2. *Taxiphyllum taxirameum* (Mitt.) Fleisch. *(Plagiothecium geophilum)* In open to closed woods; on forest soil or more often on thin soil over sandstone rock. Occasional. Eastern half of Kansas.

Reference: Ireland (1969*b*).

Thelia Sull. Theliaceae

1. Leaf cell papillae simple, not branched . . . . . 2. *T. hirtella*
1. Leaf cell papillae branched . . . . . 2.
   2. Stems creeping, radiculose; leaves ciliate-papillose above, long-ciliate below along margin; acute or obtuse, long apiculate or piliform-apiculate; most often on tree trunks . . . . . 1. *T. asprella*
   2. Stems crowded and ascending; not or only slightly radiculose; leaves not or somewhat ciliate-papillose along margin, not long-ciliate below; obtuse, short-apiculate; most often on soil or rock . . . . . 3. *T. lescurii*

1. *Thelia asprella* Sull. In woods; on base trunk of trees (including *Quercus muehlenbergii* and *Ulmus americana*), and sometimes on decaying wood as well. C.fr. Occasional. Eastern third of Kansas.
2. *Thelia hirtella* (Hedw.) Sull. In woods; on limestone rock. Uncommon. Eastern third of Kansas.
3. *Thelia lescurii* Sull. In open to closed woods, occasionally found in prairies;

most often on sandstone rock or sandy soil, and occasionally found on limestone. Occasional. Eastern half of Kansas.

NOTE: Experimental studies by Gier & Kennedy (1955) suggested that *Thelia lescurii* is only an environmental form of *T. asprella.* This hypothesis needs further detailed testing. I have followed the taxonomic study by Crum in the present treatment. Evidence from field work in Kansas tends to support the hypothesis that these are two distinct taxa. Reference: Crum (1966).

Thuidium B.S.G. Thuidiaceae

1. Paraphyllia with papillae at the upper ends of the cells; costa filling the acumen . . . . . 2. *T. recognitum*
1. Paraphyllia with papillae mostly in the middle of the cells; costa ending below the apex and not filling the acumen . . . . . 1. *T. delicatulum*

1. *Thuidium delicatulum* (Hedw.) B.S.G. In woods; on moist soil, often bank slopes, and soil over sandstone. Uncommon c.fr. Frequent. Eastern third of Kansas.
2. *Thuidium recognitum* (Hedw.) Lindb. In woods; on limestone, and sandy soil. Uncommon. Southeastern Kansas.

Timmia Hedw. Timmiaceae

1. *Timmia megapolitana* Hedw. In woods; on moist shaded bank slopes. C.fr. Occasional. Northeast Kansas.

Tortella (Lindb.) Limpr. Pottiaceae

1. *Tortella humilis* (Hedw.) Jenn. In woods; partly to fully shaded on moist to dry sandy soil, sandstone rock, and on base trunk of trees. C.fr. Occasional. Southeast Kansas.

Tortula Hedw. Pottiaceae

1. Leaves with a short ± folded mucro tip; lacking both propagula and a long serrulated hyaline awn . . . . . 1. *T. cainii*
1. Leaves with a hyaline, short or long awn . . . . . 2.
   2. Leaves with a short, smooth to rough awn; margins of leaf plane; propagula present in axil of leaves . . . . . 2. *T. pagorum*
   2. Leaves with a long, serrated awn; distinctly revolute margins; propagula absent . . . . . 3. *T. ruralis*

1. *Tortula cainii* Crum & Anderson. In plains grassland; on calcareous soil and rock. Rare. Known thus far from one locality in Kansas, Gove County. This Kansas record was recently reported as new to the United States by Churchill (1980). Previously this *Tortula* species had only been recorded from a few sites in Ontario, Canada (Zander & Eckel, 1980). This interesting *Tortula* should be sought elsewhere in the Plains region.
2. *Tortula pagorum* (Milde) De Not. In usually open, often dry woods; on bark of trees (including *Juglans nigra, Juniperus virginiana, Quercus marilandica,* and *Ulmus* sp.). Propagula present. Frequent. Eastern two-thirds of Kansas.
3. *Tortula ruralis* (Hedw.) Gaertn., Meyer & Schreb. In plains grassland; on gypsum, sandy or calcareous soils, and thin soil over gypsum and sandstone rocks. Occasional. Western half of Kansas.

Weissia Hedw. Pottiaceae

1. Costa at leaf base ca. 60 um wide; peristome present, slender or often poorly

developed . . . . . 1. *W. controversa*

1. Costa at leaf base 70 um or more wide; peristome represented by a mere fragile membrane . . . . . 2. *W. tortilis*

1. *Weissia controversa* Hedw. *(Weisia viridula)* In open woods, prairies and plains, often in disturbed sites; exposed to shaded soil, and soil over limestone and sandstone. C.fr. Very common. Throughout Kansas. See comments under *Astomum.*
2. *Weissia tortilis* (Schwaegr.) C. Muell. In plains grassland; exposed on soil. C.fr. Occasional. Western Kansas. The report by Smith (1966) of *W. glauca* Bartr. is this taxon.

SUMMARY OF CORRECTIONS FOR THE KANSAS MOSS FLORA

Acaulon triquetrum (Spruce) C. Muell. reported by Cridland (1960) has not been examined—until verification, this taxon is deleted from the flora.

Aloina brevirostris (Hook. & Grev.) Kindb. reported by Cridland (1960) is most likely *A. rigida* (Hedw.) Limpr.; specimen not examined, but see Delgadillo M. (1975) for major distribution of the two taxa, and Churchill (1979*b* & 1980) for *A. rigida* records for Kansas.

Aphanorrhegma serratum (J. Hook. & Wils. *ex* Drumm.) Sull. reported by McGregor (1950) could not be located at NY and is deleted until verified.

Brachythecium calcareum Kindb. *(B. flexicaule)* reported by McGregor (1950) is *B. oxycladon* (Brid.) Jaeg. & Sauerb.

Brachythecium salebrosum (Web. & Mohr) B.S.G. *(Chamberlainia)* reported by McGregor (1950) and Smith (1966) is *B. oxycladon* (Brid.) Jaeg. & Sauerb. except in one case (*Smith 1944,* NY!) which is *B. collinum* (Schleich. *ex* C. Muell.) B.S.G.

Brachythecium velutinum (Hedw.) B.S.G. *(Chamberlainia)* reported by Smith (1966) is *Rhynchostegiella compacta* (C. Muell.) Loeske.

Brotherella recurvans (Michx.) Fleisch. reported by McGregor & Hartman (1956) is *Hypnum curvifolium* Hedw.

Cratoneuron filicinum (Hedw.) Spruce reported by McGregor (1950) is *Amblystegium riparium* (Hedw.) B.S.G.

Dichodontium pellucidum (Hedw.) Schimp. reported by Smith (1966) is *Aulacomnium palustre* (Hedw.) Schwaegr.

Fabronia imperfecta Sharp reported by Smith (1966) is *F. ciliaris* (Brid.) Brid.

Fabronia wrightii Sull. reported by McGregor (1950) is *F. ciliaris* (Brid.) Brid.

Fissidens bushii (Card. & Ther.) Card. & Ther. reported by McGregor (1950) is *F. subbasilaris* Grout.

Fissidens osmundioides Hedw. reported by Smith (1966) is *F. obtusifolius* Wils.

Grimmia olneyi Sull. reported by McGregor and Hartman (1956) is *G. pulvinata* (Hedw.) Sm.

Gymnostomum recurvirostrum Hedw. reported by McGregor (1950) could not be located at NY and is deleted until verified.

Homomallium mexicanum Card. reported by Smith (1966) is *Hypnum vaucheri* Lesq.

Hypnum cupressiforme Hedw. reported by Smith (1966) is *H. vaucheri* Lesq.

Leucobryum albidum (Brid. *ex* P.-Beauv.) Lindb. reported by McGregor

(1950) is not represented by specimen at NY, and is excluded. Smith (1961) likewise did not include this species for the Chautauqua Hills where McGregor's collection was made.

Leucodon brachypus Brid. is excluded based on questionable label data on a specimen deposited with NY.

Mnium affine Bland *ex* Funck reported by McGregor (1950), and by Magill and Kirkpatrick (1976) is *Plagiomnium ciliare* (C. Muell.) T. Kop.

Orthotrichum sordidum Sull. & Lesq. *ex* Aust. reported by McGregor (1950) is *O. pusillum* Mitt., see Vitt (1973), specimen at NY!; a duplicate specimen (*Holland 93,* KSC!) contains *O. pumilum* Sw., as well as *O. pusillum.*

Philonotis glaucescens (Hornsch.) Broth. reported by Flowers in Grout (1928-1940) is excluded. No specimen could be located for this report from Kansas but the distribution is mainly southeastern United States and tropical regions further south. Zales (pers. comm.) has not found any record for Kansas in his revisionary work on this genus.

Philonotis gracillima Ångstr. reported by Flowers in Grout (1928-1940) is *P. marchica* (Hedw.) Brid.

Physcomitrium acuminatum (Schleich.) B.S.G. reported by McGregor & Hartman (1956) is *P. pyriforme* (Hedw.) Hampe.

Platydicta confervoides (Brid.) Crum *(Amblystegiella)* reported by McGregor (1950) is deleted as no specimen could be located at NY.

Platydicta subtile (Hedw.) Crum *(Amblystegiella)* reported by Smith (1966) is *Pesudoleskeella tectorum* (Funck *ex* Brid.) Kindb. *ex* Broth.

Pleuridium sullivantii Aust. reported by McGregor (1950) is deleted from the flora. Likewise, Smith (1961) excluded this taxon from his study on the Chautauqua Hills. No specimen could be located at NY.

Pottia arizonica Wareham reported by Smith (1966) is excluded from the flora as too little material is present in Smith's collection (NY!) to provide a positive identification.

Pogonatum pensilvanicum (Hedw.) P.-Beauv. reported by McGregor & Hartman (1956) is *P. brachyphyllum* (Michx.) P.-Beauv.

Sphagnum trinitense C. Muell. reported by Churchill (1979*b*) is *S. cuspidatum* Hoffm.; see discussion under *S. cuspidatum.*

Weissia glauca Bartr. reported by Smith (1966) is *Weissia tortilis.* Determination made by Ann Stoneburner.

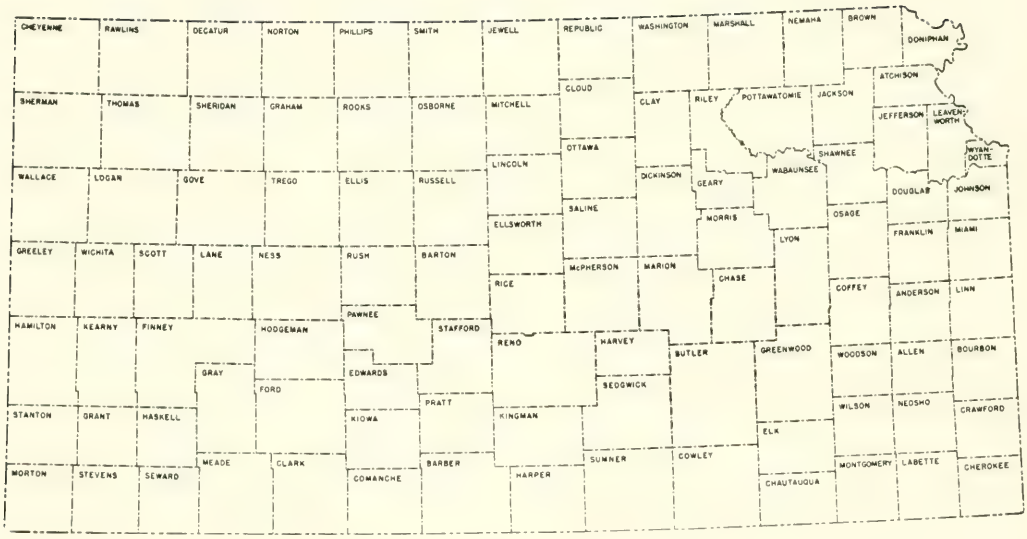
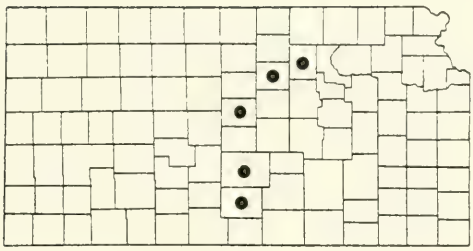
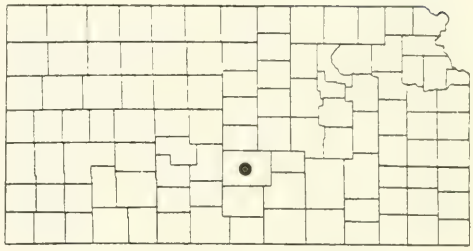


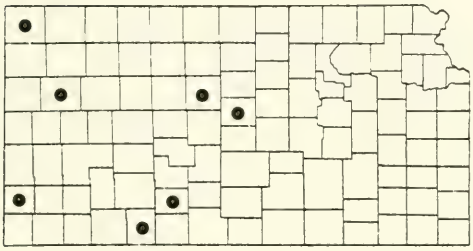
FIG. 5. County locations in Kansas.



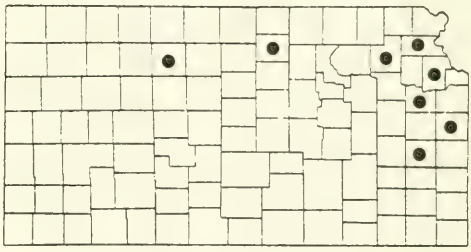
ACAULON MUTICUM



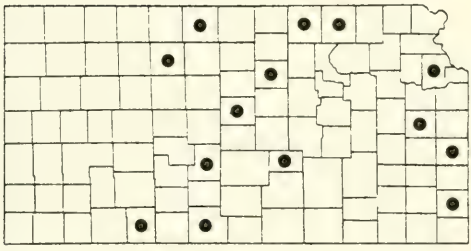
ACAULON SCHIMPERIANUM



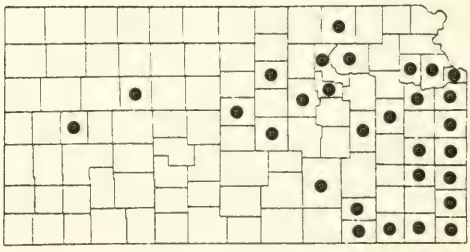
ALOINA RIGIDA



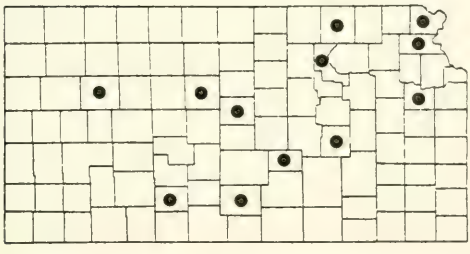
AMBLYSTEGIUM RIPARIUM



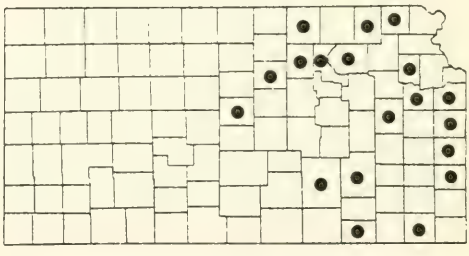
AMBLYSTEGIUM SERPENS



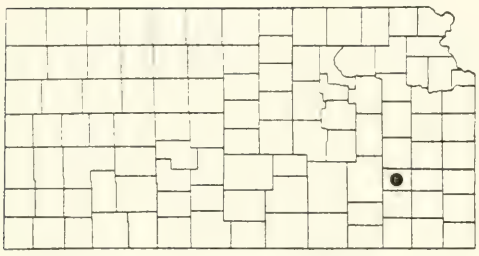
AMBLYSTEGIUM TENAX



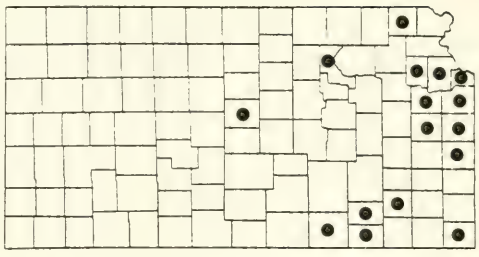
AMBLYSTEGIUM TRICHOPODIUM



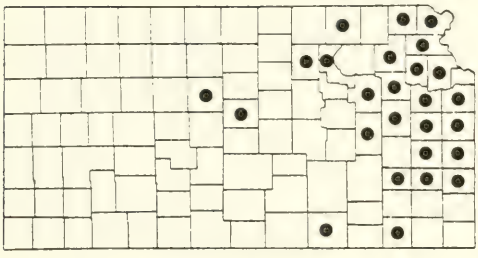
AMBLYSTEGIUM VARIUM



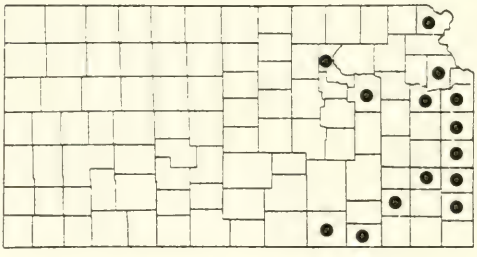
ANOMOBRYUM FILIFORME



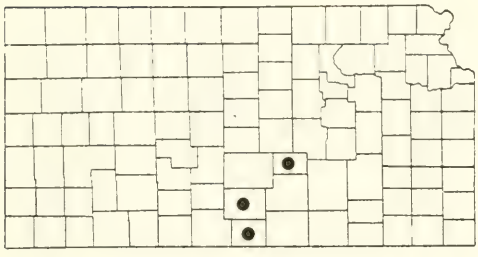
ANOMODON ATTENUATUS



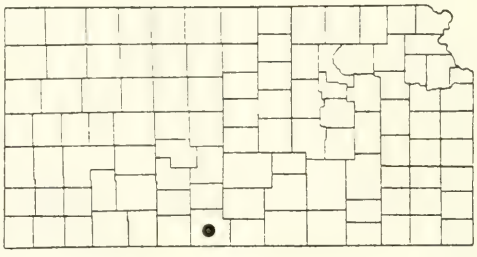
ANOMODON MINOR



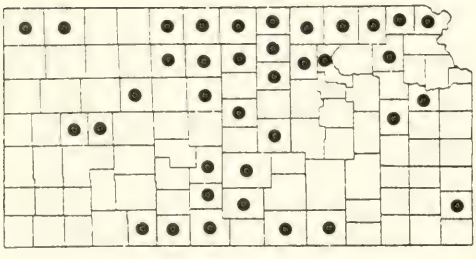
ANOMODON ROSTRATUS



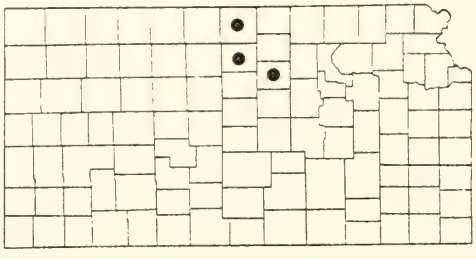
ARCHIDIUM OHIOENSE



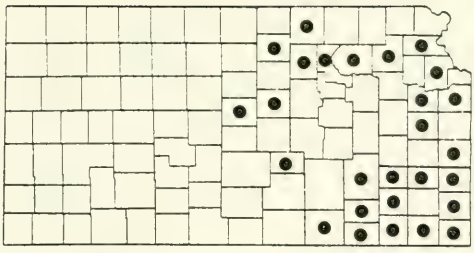
ASCHISMA KANSANUM



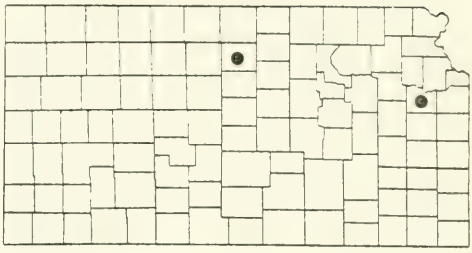
ASTOMUM MUHLENBERGIANUM



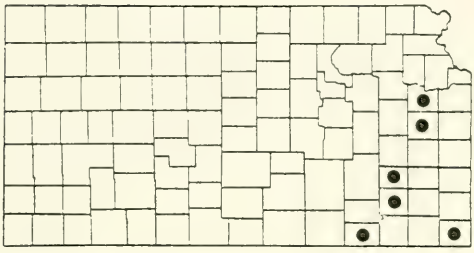
ASTOMUM PHASCOIDES



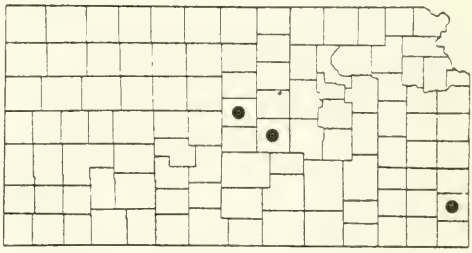
ATRICHUM ANGUSTATUM



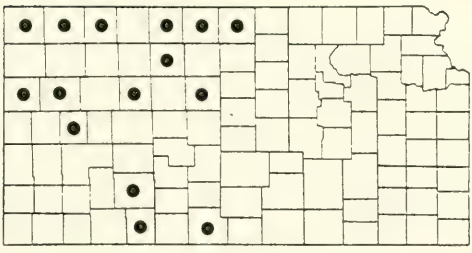
ATRICHUM UNDULATUM



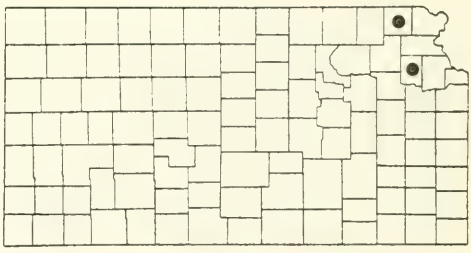
AULACOMNIUM HETEROSTICHUM



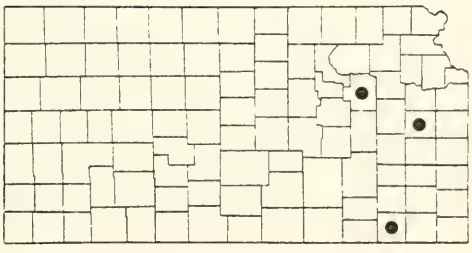
AULACOMNIUM PALUSTRE



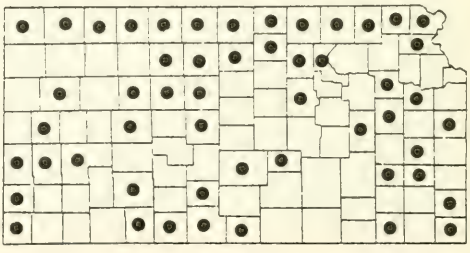
BARBULA ACUTA



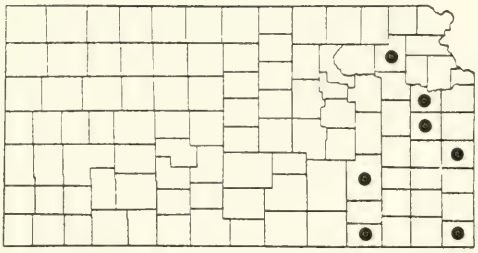
BARBULA FALLAX



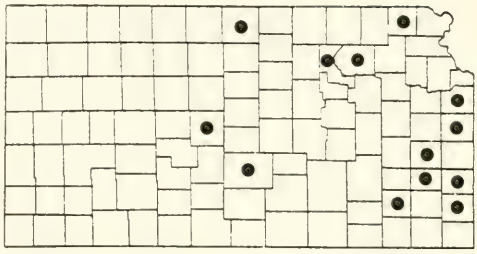
BARBULA INDICA



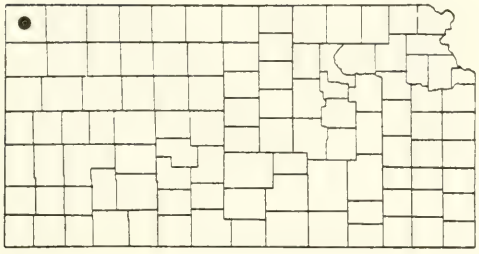
BARBULA UNGUICULATA



BARTRAMIA POMIFORMIS



BRACHYTHECIUM ACUMINATUM



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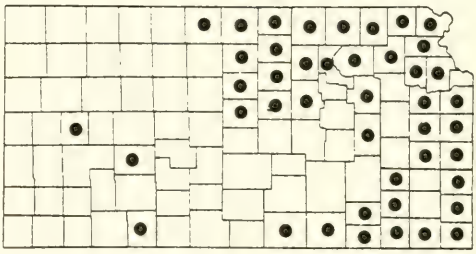
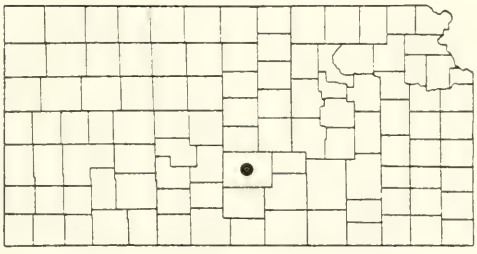
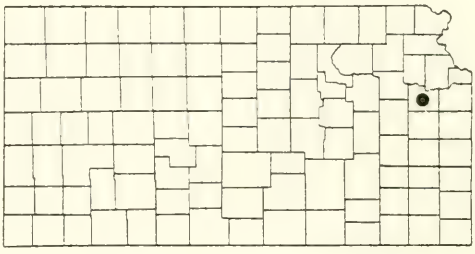


BRACHYTHECIUM OXYCLADON



BRUCHIA BREVIFOLIA



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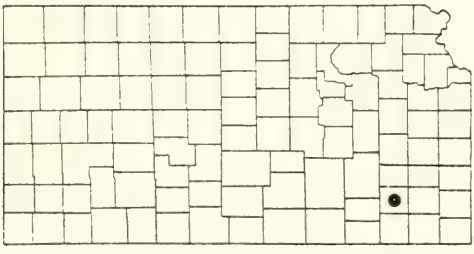

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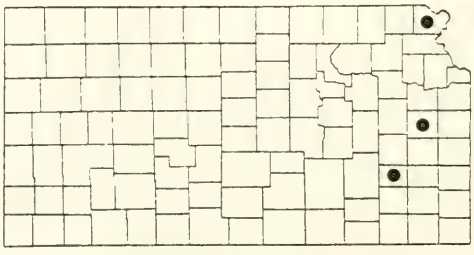
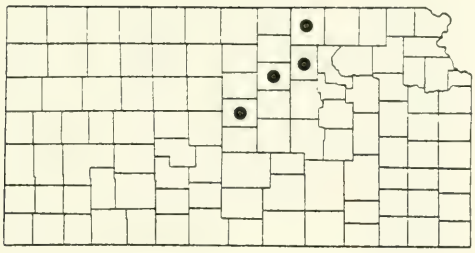
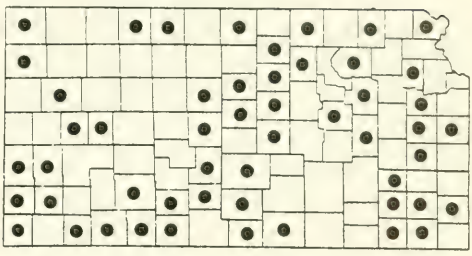


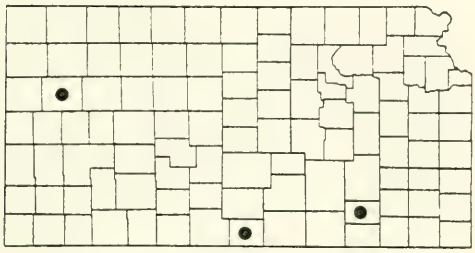
BRYHNIA GRAMINICOLOR



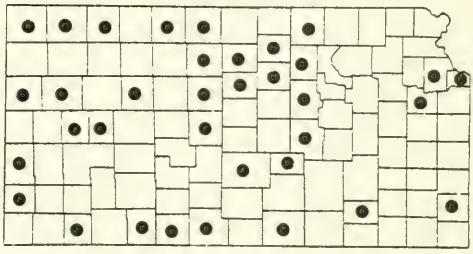
BRYUM ALGOVICUM



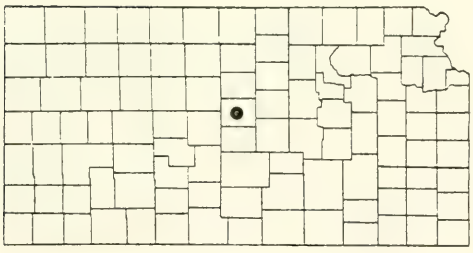
BRYUM ARGENTEUM



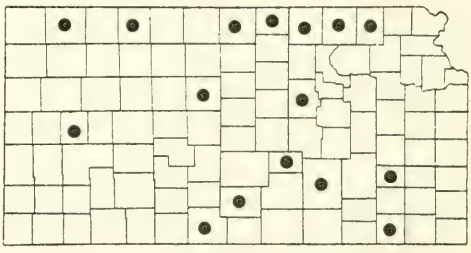
BRYUM BICOLOR



BRYUM CAESPITICIUM



BRYUM CAPILLARE



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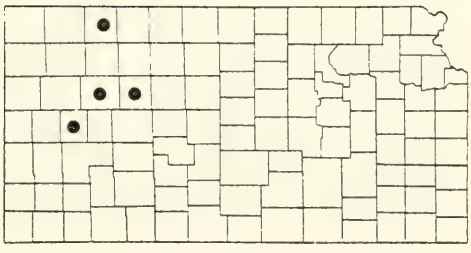

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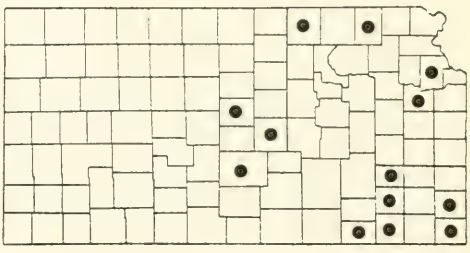

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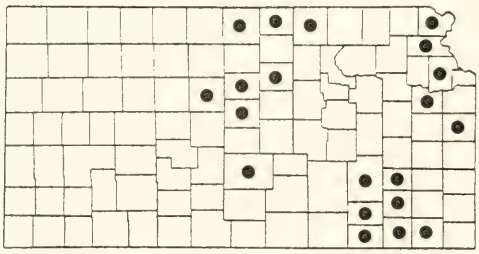

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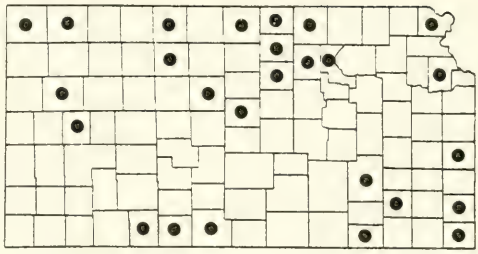

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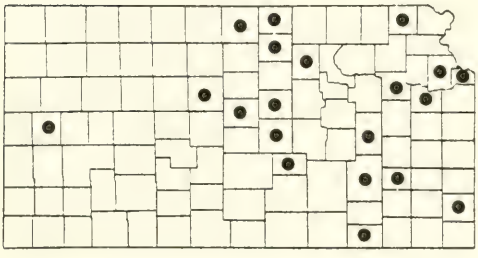

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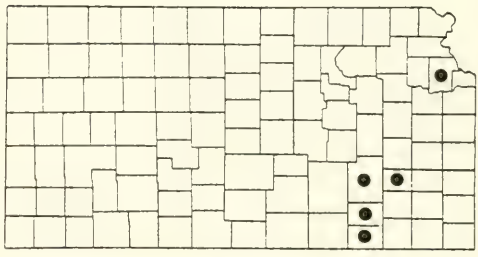

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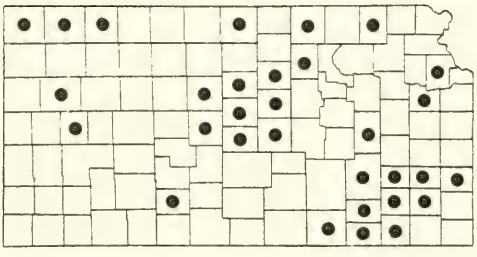

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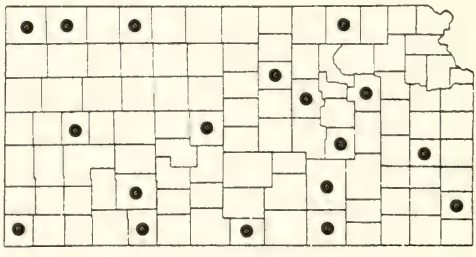

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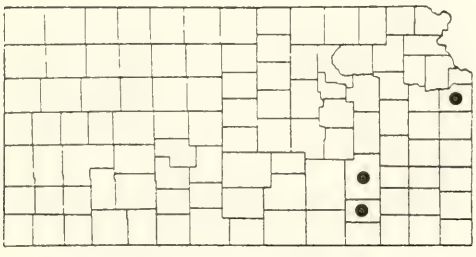

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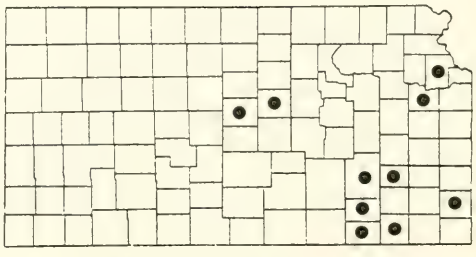

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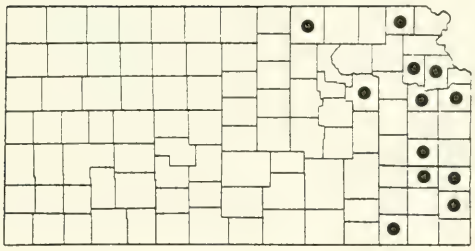

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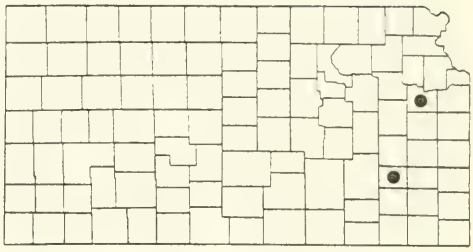

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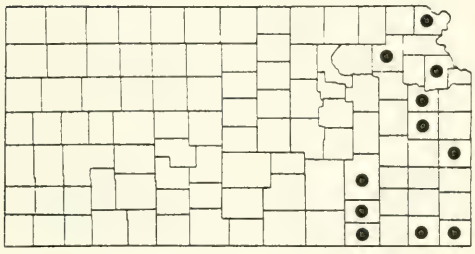

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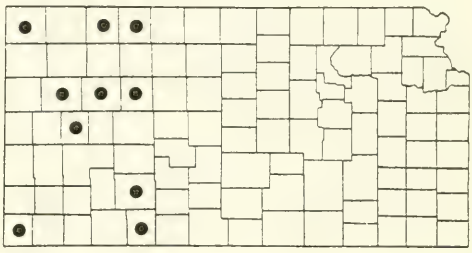

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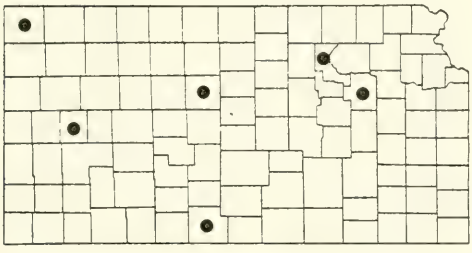

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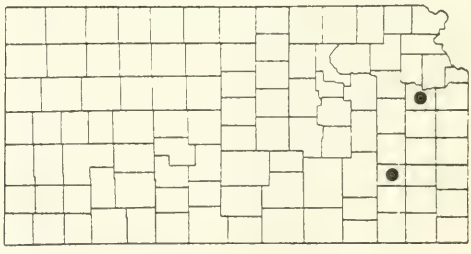

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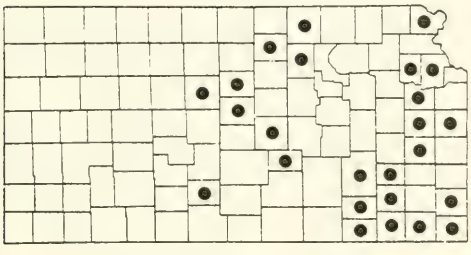

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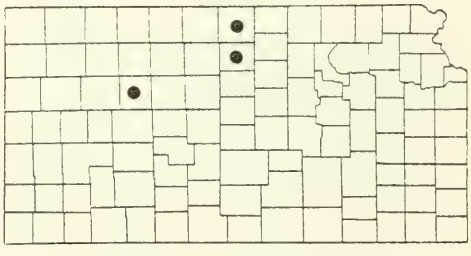

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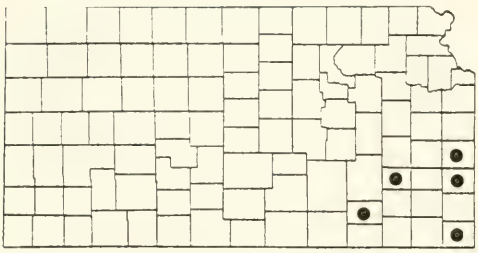

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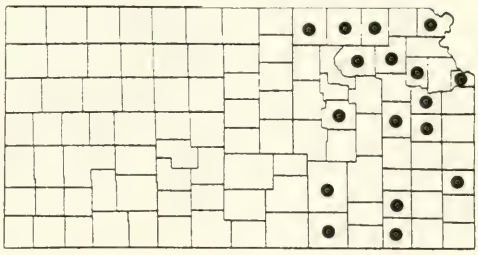

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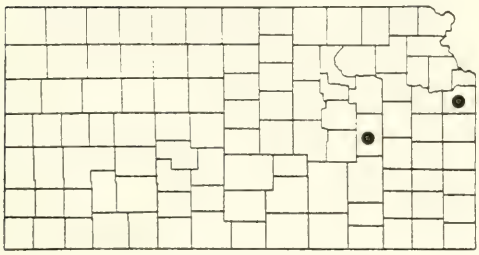

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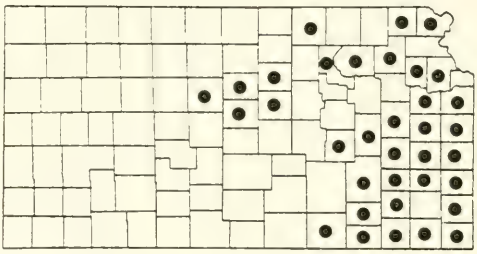

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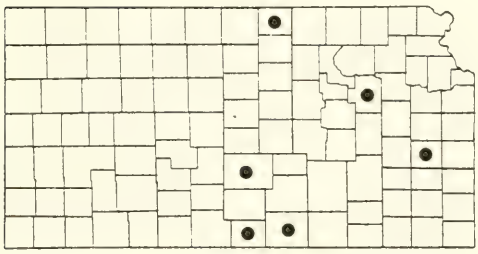

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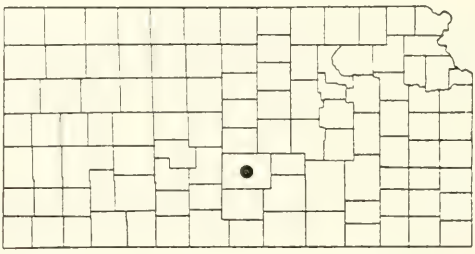

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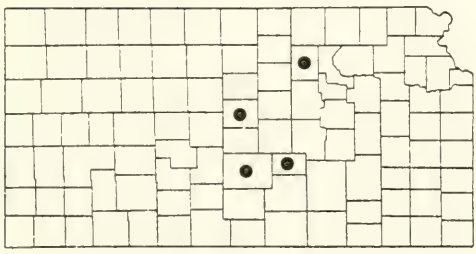

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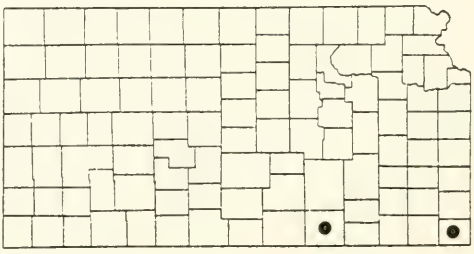

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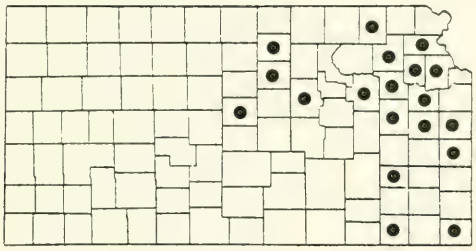

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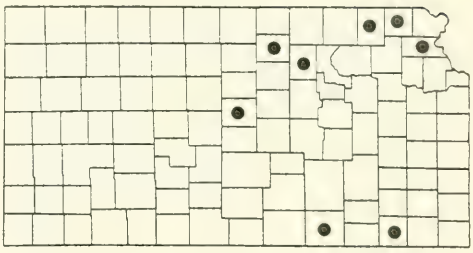

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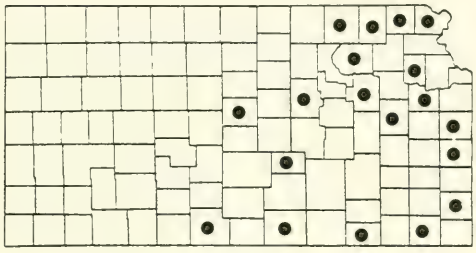

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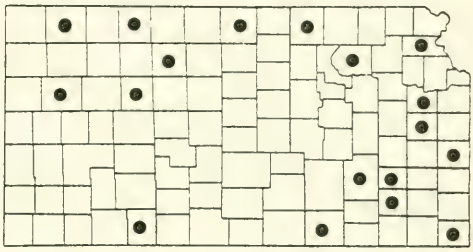

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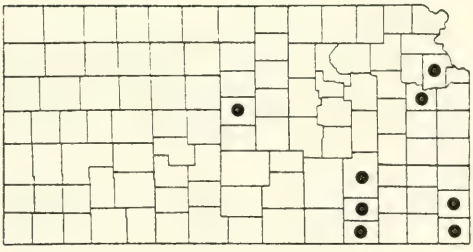

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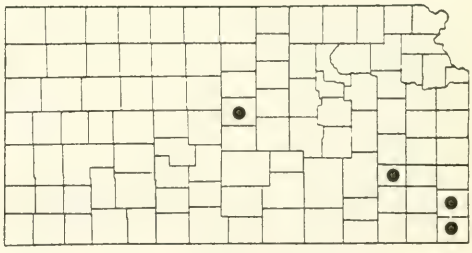

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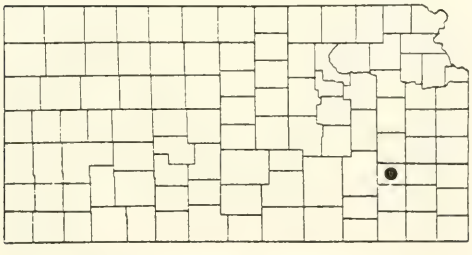

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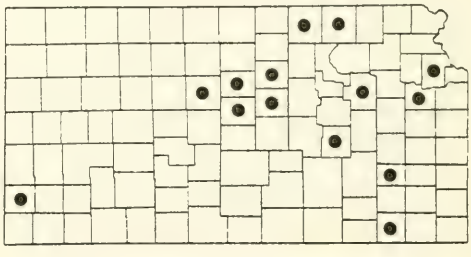

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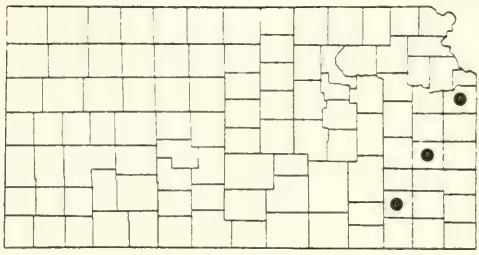

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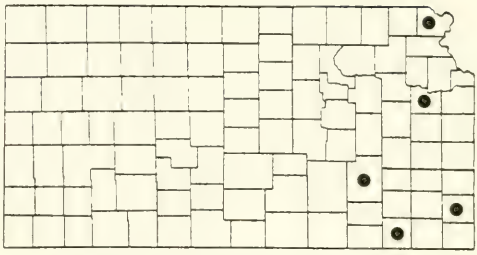

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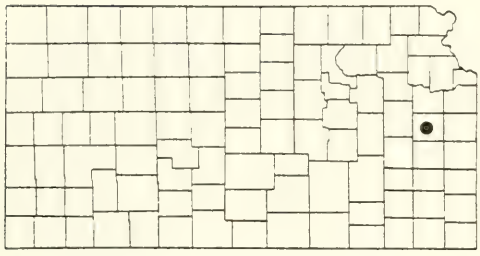

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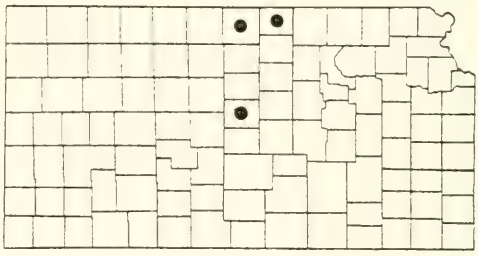

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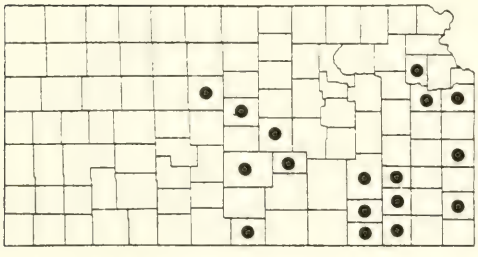

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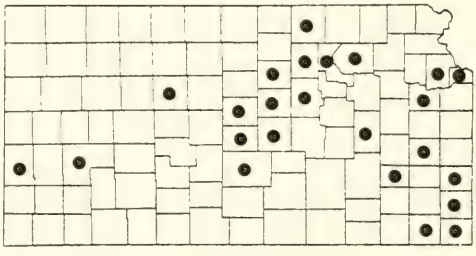

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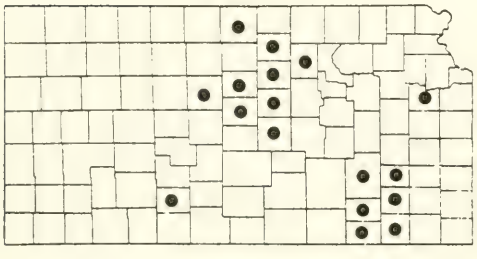

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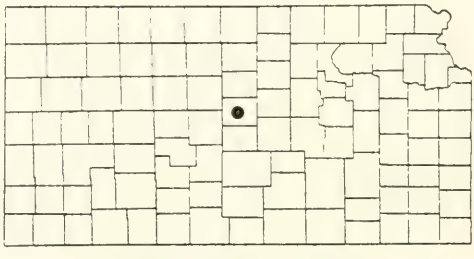

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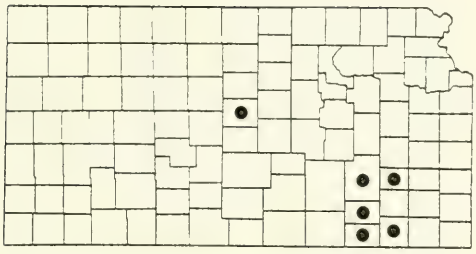

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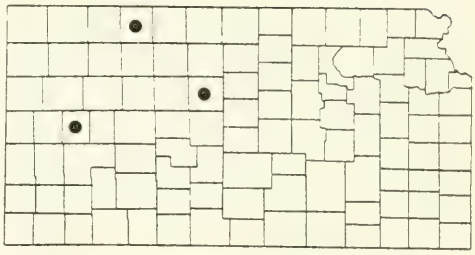

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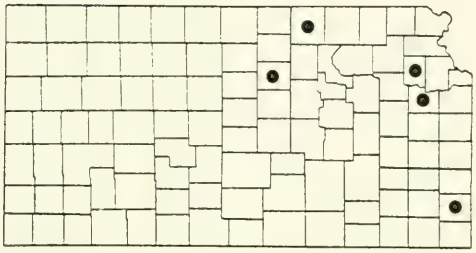

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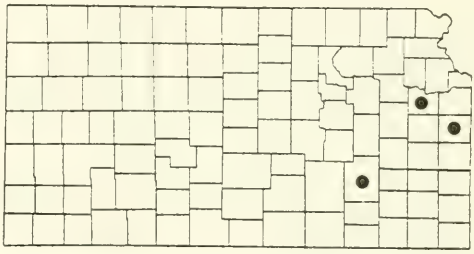

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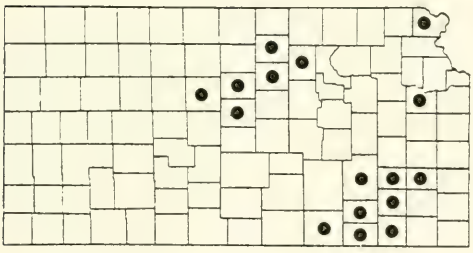

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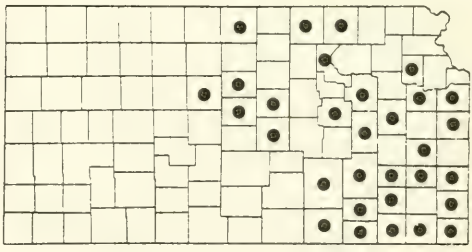

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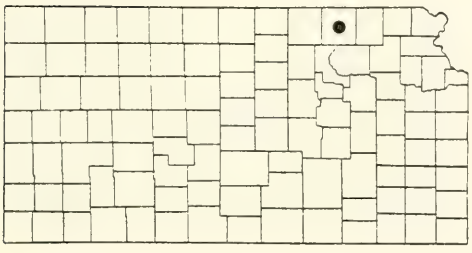

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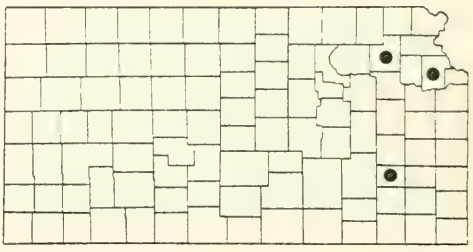

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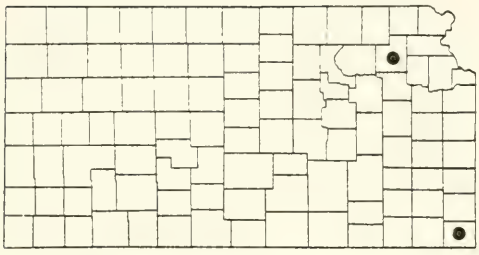

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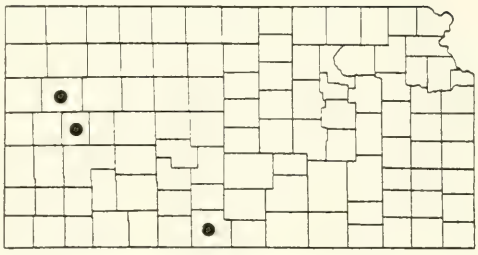

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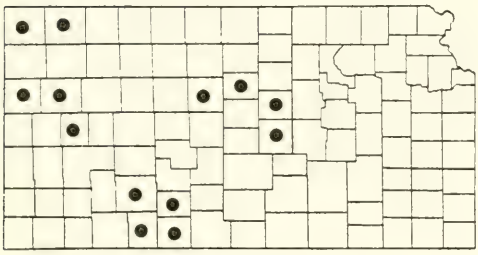

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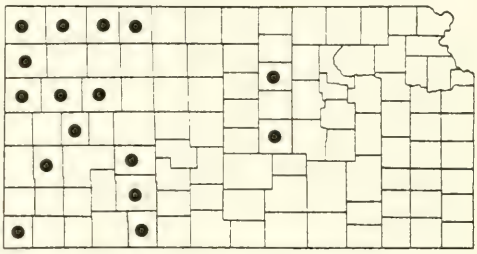

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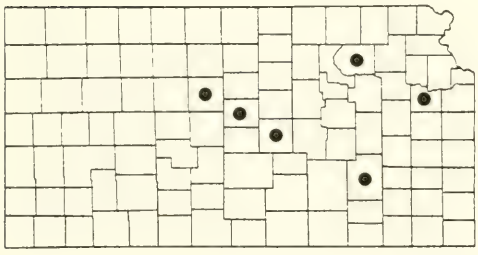

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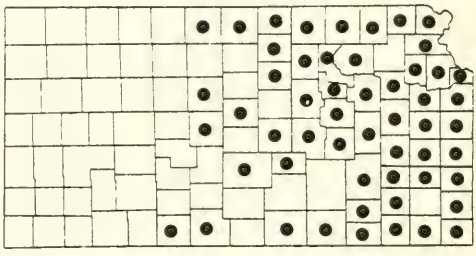

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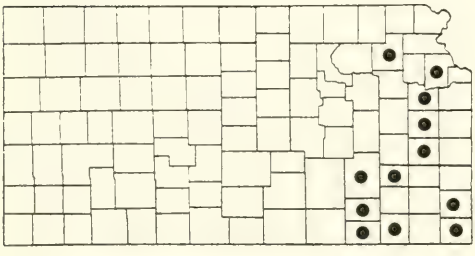

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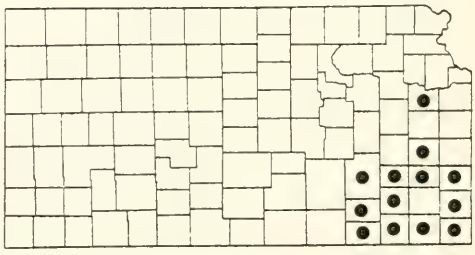

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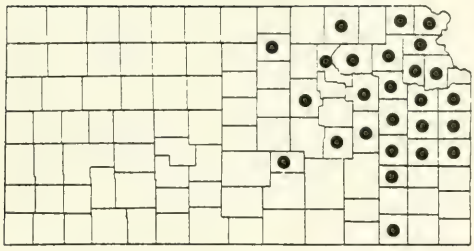

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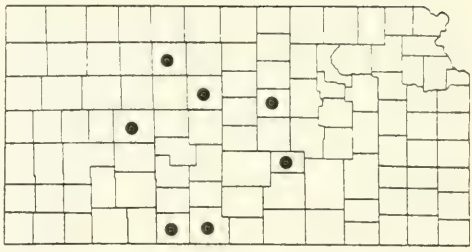

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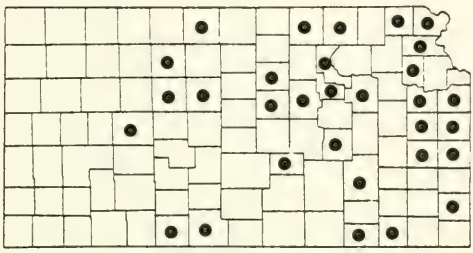

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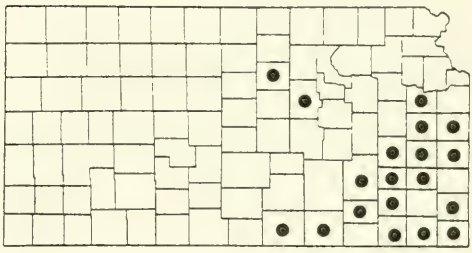

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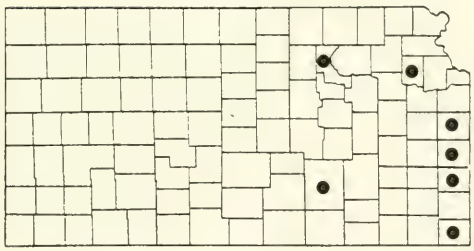

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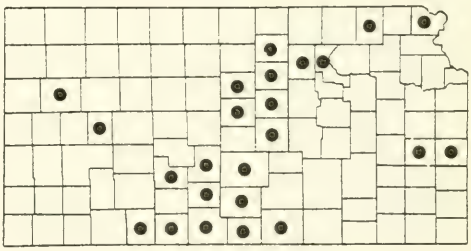

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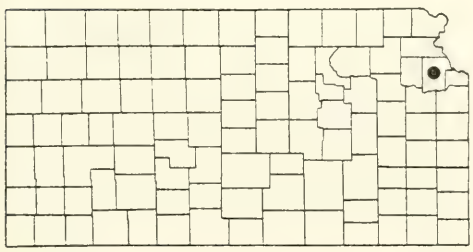

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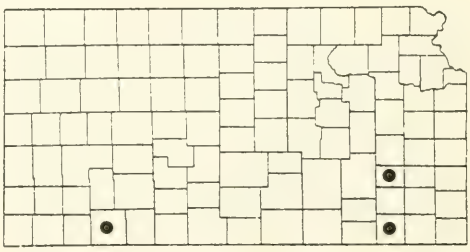

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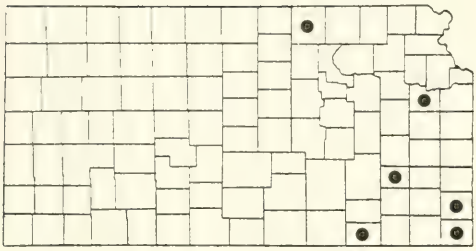

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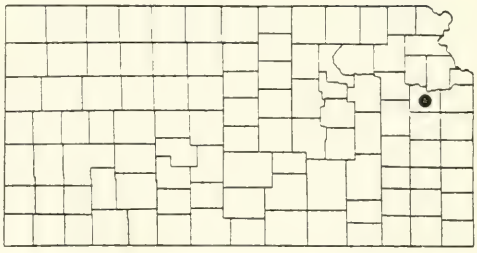

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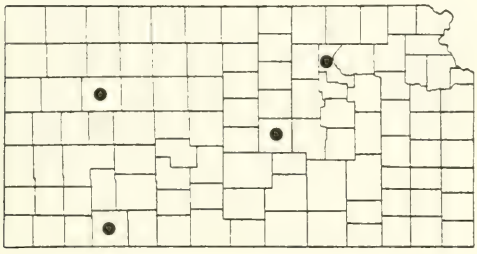

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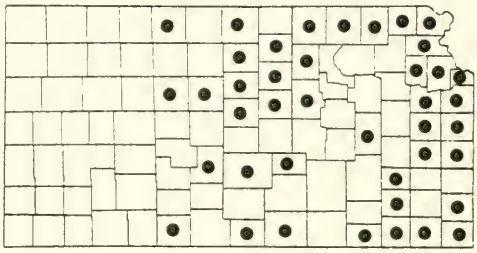

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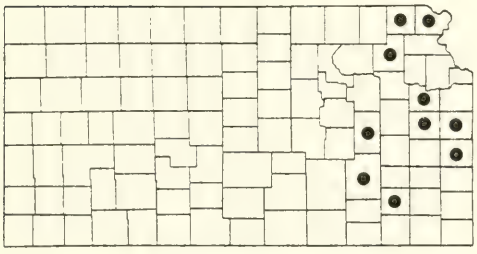

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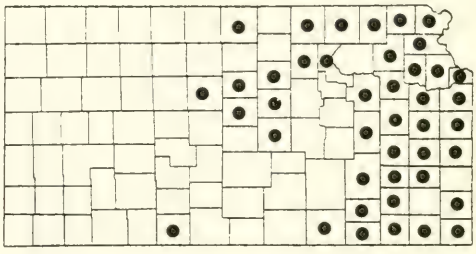

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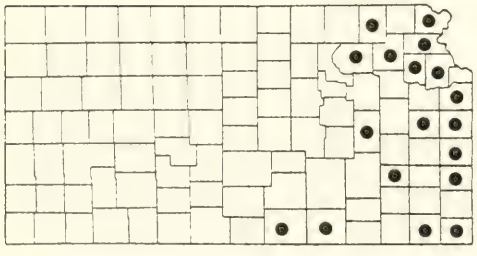

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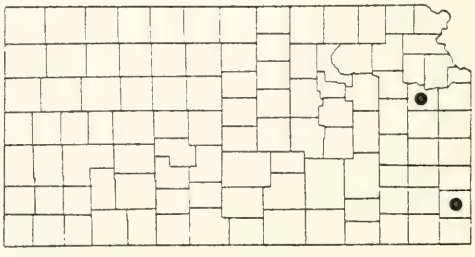

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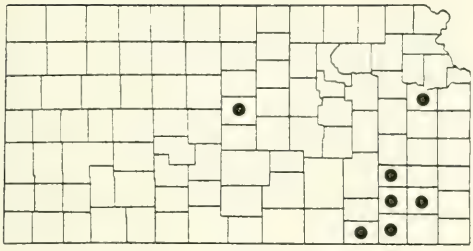

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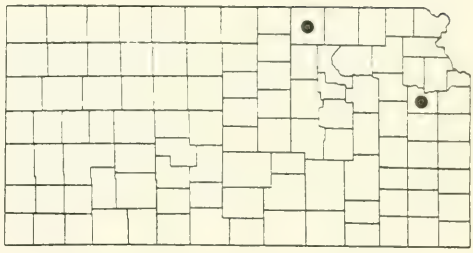

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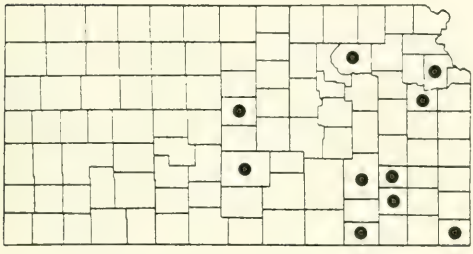

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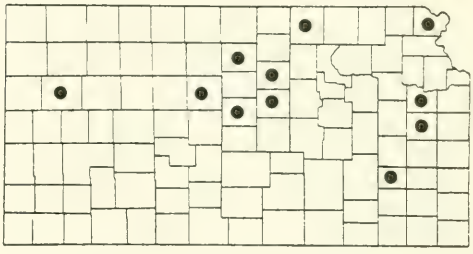

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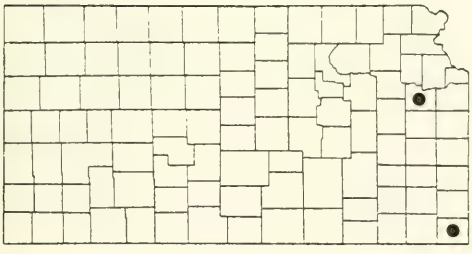

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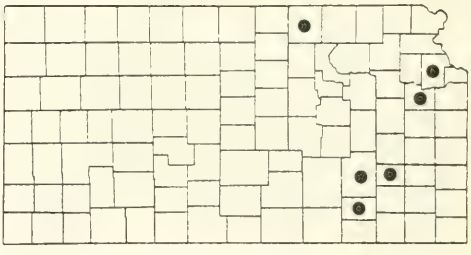

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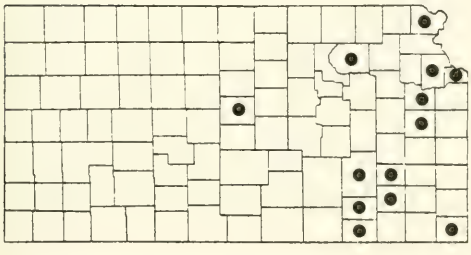

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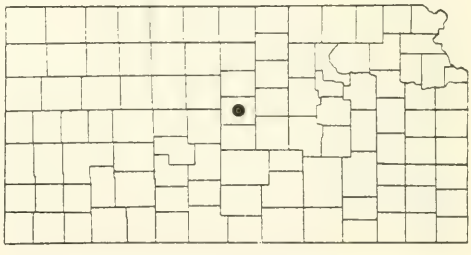

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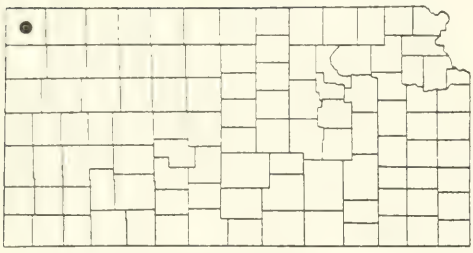

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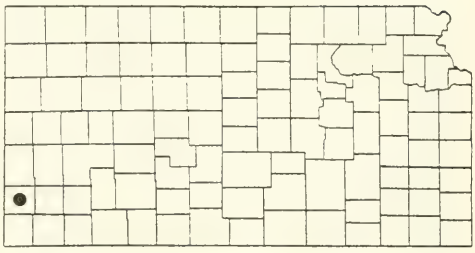

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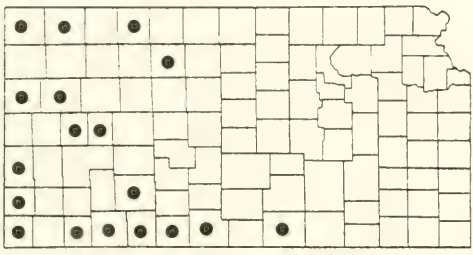

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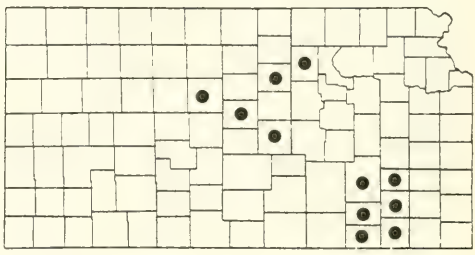

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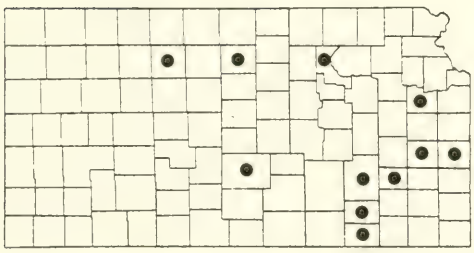

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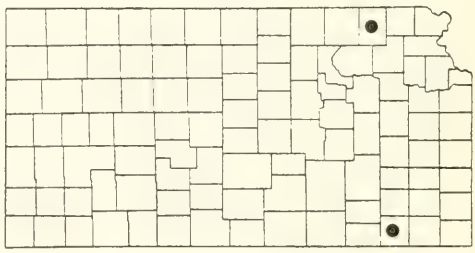

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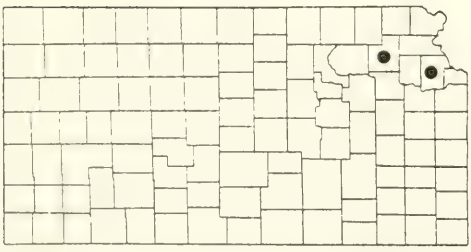

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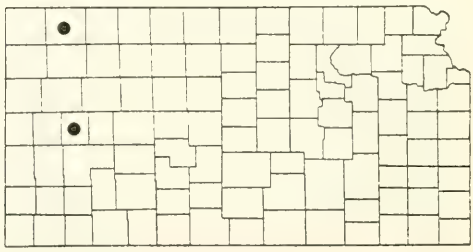

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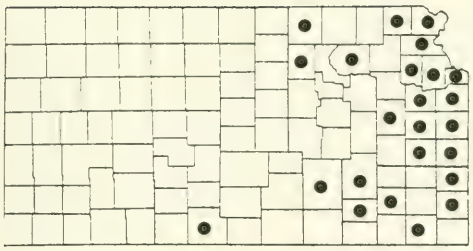

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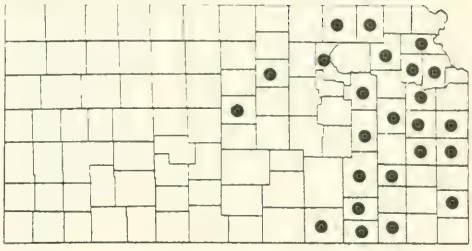

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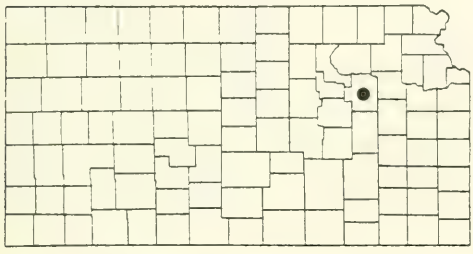

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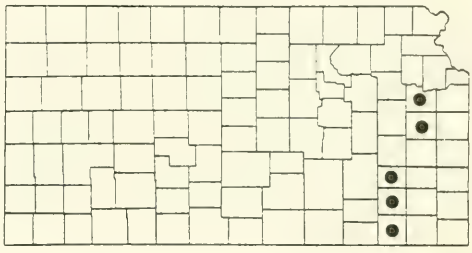

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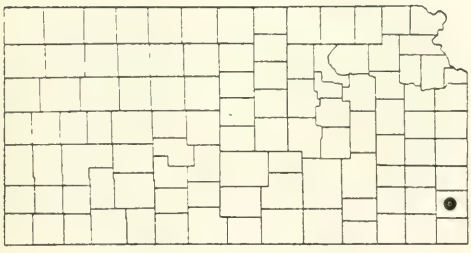

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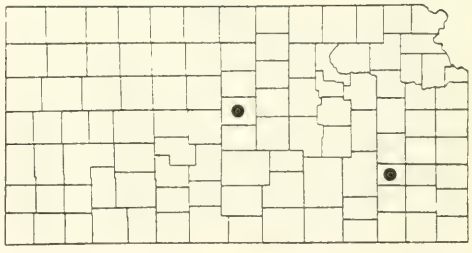

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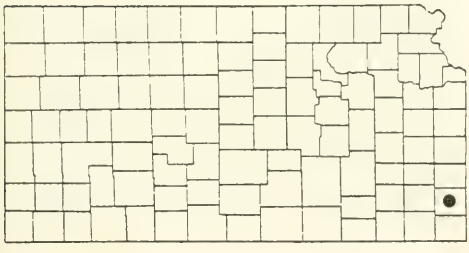

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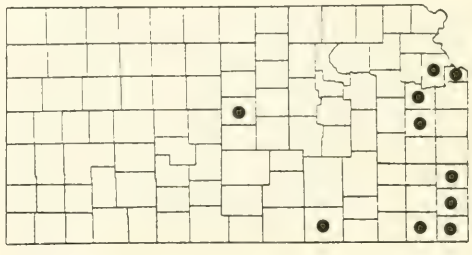

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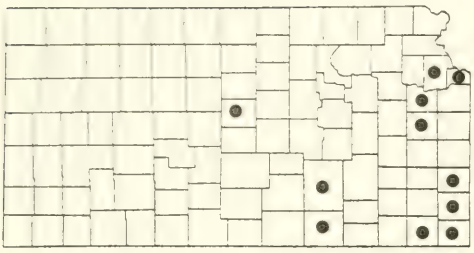

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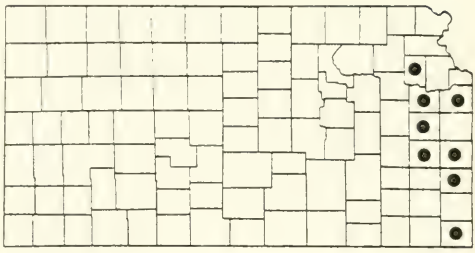

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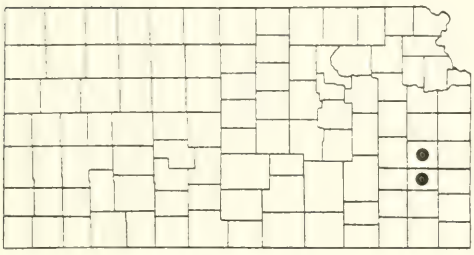

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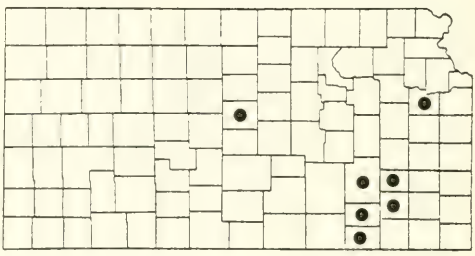

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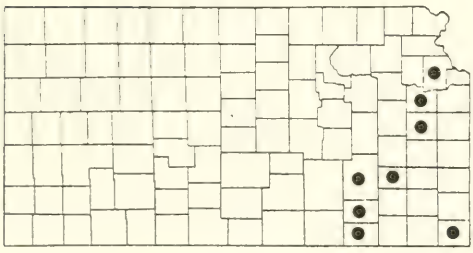

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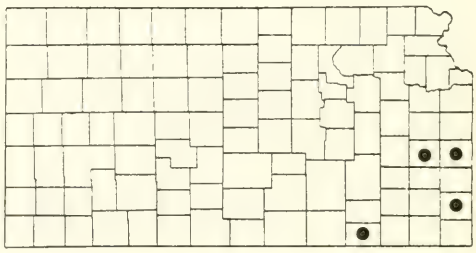

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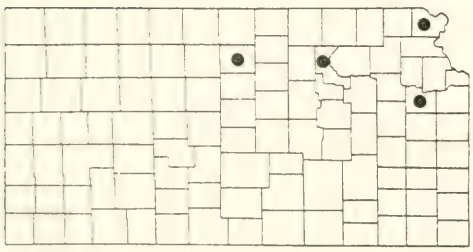

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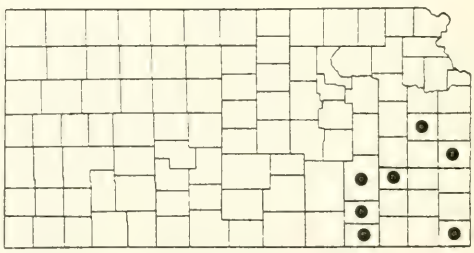

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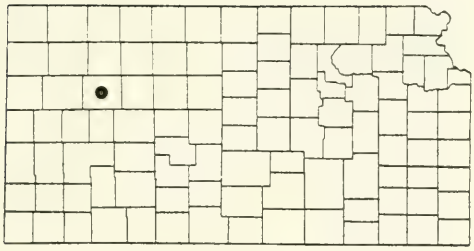

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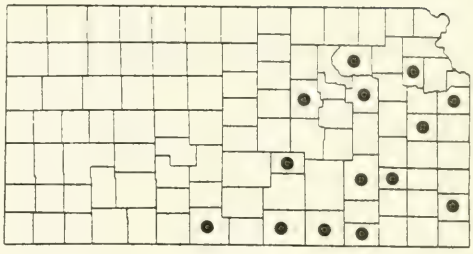

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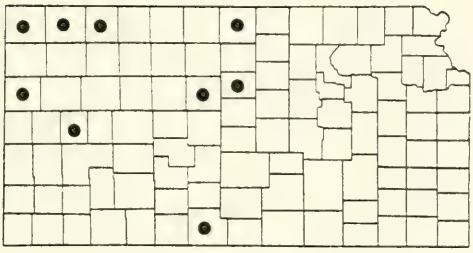

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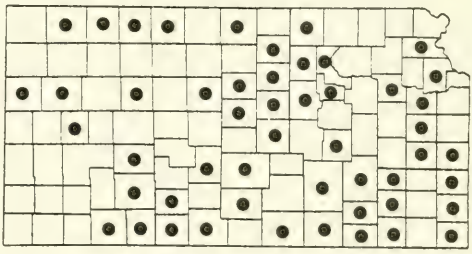

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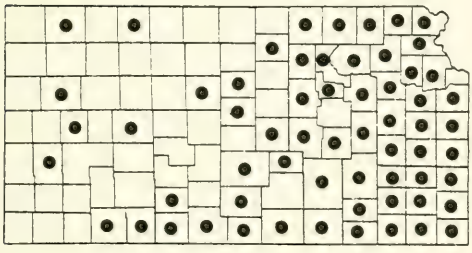
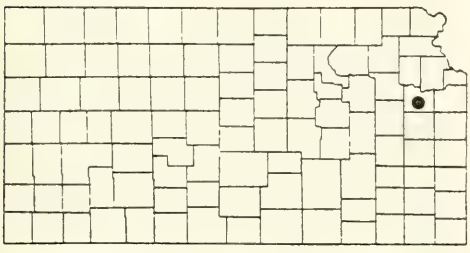


AUTHORS COLLECTION SITES

ADDENDUM



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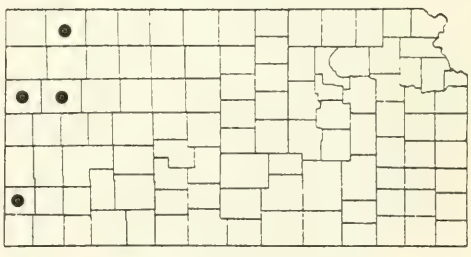

WEISSIA TORTILIS

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APPENDIX

A list of Kansas moss collectors is given below and is based on collections that I have personally examined over several years at various herbaria. To denote where each collectors specimens are deposited I have indicated only the main institutional collections. Herbarium abbreviations are: CANM, National Herbarium of Canada, Ottawa; DUKE, Duke University, Durham; KANU, University of Kansas, Lawrence; KSC, Kansas State University, Manhattan; MO, Missouri Botanical Garden, St. Louis; NEB, University of Nebraska, Lincoln; NY, New York Botanical Garden, Bronx; PC, Herbier du Laboratoire de Cryptogamic du Museum National d' Histoire Naturelle, Paris.

Kansas Moss Collectors

Agrelius, F. U. G. (NY)
Barber, M. A. (NY)
Barker, William (NY)
Bartholomew, E. (NY)
Bass, J. C. (MO)
Beede, J. W. (NY)
Bennett, Rev. John (MO, NY)
Brooks, Ralph (KANU)
Carleton, M. A. (NY)
Churchill, S. P. (MO, NY, KANU)
Cridland, Arthur A. (DUKE)
Demetrio, C. H. (NY)
Ellison, Marlon (NY)
Fraser, S. V. (NY)
Gates, Frank (KSC)
Gier, L. J. (NY)
Hall, Elihu (NY)
Hancin, John (NY)
Hartman, Emily L. (NY)
Herrick, C. Judson (NY)
Holland, W. W. (NY)
Horr, W. H. (NY)
Henry, Joseph (NY, PC)
Ikenberry, Gilford J. (MO, NY)
Ireland, Robert R. (CANM, NEB)
Jones, Mary (NY)
Kellerman, Williams (NY)
Kirkpatrick, Randy (MO)
McClung, Frank (NY)
McGregor, Ronald L. (KANU, NY)
Meeker, Grace (NY)
Norton, J. B. S. (NY)
Reed, Minnie (KSC, NY)
Richards, B. (NY)
Riley, ? (NY)
Roth, Stan (KANU)
Showalter, W. (NY)
Smith, Harold L. (NY)
Smyth, Bernard B. (NY)
Swingle, W. (NY)
Thomas, O. E. (NY)
Thompson, Rufus (NY)
Ungar, I. A. (NY)
Vitt, Dale (NY)
Volle, L. E. (NY)
Waller, W. T. (MO)
Waters, L. (NY)
Wells, P. V. (MO, KANU)

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A Revision of the Native New World Species of the Ant Genus *Monomorium* (*minimum* Group) (Hymenoptera: Formicidae)

By
Mark B. DuBois

Vol. 53, No. 2, pp. 65-119 March 24, 1986

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THE UNIVERSITY OF KANSAS
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A Revision of the Native New World Species of the Ant Genus *Monomorium* (*minimum* Group) (Hymenoptera: Formicidae)[1]

Mark B. DuBois[2]

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ABSTRACT

Thirteen species (4 new) of native North and Central American ants closely related to *Monomorium minimum,* "*minimum* group," are included in this revision: *M. compressum* Wheeler, *M. cyaneum* Wheeler (=*M. emersoni* Gregg, NEW SYNONYMY), *M. ebeninum* Forel, *M. emarginatum* sp. n., *M. ergatogyna* Wheeler, *M. inquilinum* DuBois, *M. marjoriae* sp. n., *M. minimum* (Buckley), *M. pergandei* (Emery), *M. talbotae* DuBois, *M. trageri* sp. n., *M. viridum* Brown (=*M. peninsulatum* Gregg, NEW SYNONYMY), and *M. wheelerorum* sp. n. Lectotypes are designated for *M. compressum, M. cyaneum, M. ebeninum,* and *M. ergatogyna.* All species are described, illustrated, and their distributions are mapped. Keys are provided for identification of queens, known males, and known workers.

This species group inhabits the New World from southern Canada to Panama. Two species, *M. minutum brasiliense* Forel (known only from Brazil) and *M. subcoecum* Emery (known only from Antilles), which may belong to this group were not included due to lack of queens for comparisons.

INTRODUCTION

The ant genus *Monomorium* contains 326 currently recognized, recent species; most of these occur in the Old World (Emery, 1921; Santschi, 1927, 1936; Ettershank, 1966). Three Old World species are widely distributed "tramps" in the New World (predominantly in tropical and subtropical regions): *Monomorium (Monomorium) floricola* (Jerdon), *M. (M.) pharaonis* (Linnaeus), and *M. (Parholcomyrmex) destructor* (Jerdon) (Creighton, 1950; Brown, 1964; Kempf, 1972; Smith, 1979).

In addition to these species, Kempf (1972) lists the tropical species occurring in the New World. Two of them, *M. minutum brasiliense* Forel (1908) and *M. subcoecum* Emery (1894), may belong to the group herein revised. Lack of queens for comparisons prevented me from including them. All remaining New World species belong to different species groups.

Emery (1921) considered the *minimum* group closely related to *M. minutum* Mayr (which occurs in southern Europe). Based on published descriptions of *M. minutum* and comparison of 2 queens and 12 workers of this species (from France, Italy and Yugoslavia) with members of the *minimum* group, it appears unlikely that this species is closely related to any of the native New World *Monomorium.*

Other evidence which indirectly supports the above contention lies with plate tectonics of North America and Europe. Since Pangea probably fragmented before the Formicidae evolved, it is unlikely that *Monomorium* could have dispersed directly to North America from Europe (Wilson et al., 1967a, 1967b; Dietz and Holden, 1970; Burnham, 1978). It seems more likely that *Monomorium* arrived in North America via the Bering land bridge since a number of other species are thought to have arrived via this route (Buren, 1958). Furthermore, comparisons between workers of North American *Monomorium* and Asiatic *Monomorium (M. chinensis* Santschi, 1925) reveal many similarities (they are difficult to differentiate). However, no queens of Asiatic species were available for study.

Most studies on native New World members of the *minimum* group have been isolated descriptions of taxa with little effort made to synthesize this information. Confusion has resulted from descriptions which compare taxa being described with that author's concept of *M. minimum.* Thus, Wheeler (1904) described *M. minimum ergatogyna* and compared it with "*M. minimum*" from New England (now known as *M. emarginatum*). Later, Wheeler (1914b) described *M. minimum compressum* and *M. minimum cyaneum* and compared them with *M. minimum* from Texas (which may have been *M. minimum* or *M. cyaneum*).

GENERAL BIOLOGY

Little biological information has been recorded for most species of *Monomorium*

FIGS. 1-5. *Monomorium ergatogyna*. Scanning electron microscope photographs. Some photographs enlarged more than others; for actual dimensions, refer to text. 1—Head of male, frontal view. 2—Head of worker, frontal view. 3—Head of queen, frontal view. 4—Male, lateral view (legs and wings removed). 5—Queen, lateral view (legs removed).

(Ettershank, 1966). One notable exception is the detailed study of *M. pharaonis* (Peacock and Baxter, 1949, 1950; Peacock, 1950a, 1950b, 1951; Hall and Smith 1951, 1952, 1953; Smith and Peacock, 1957).

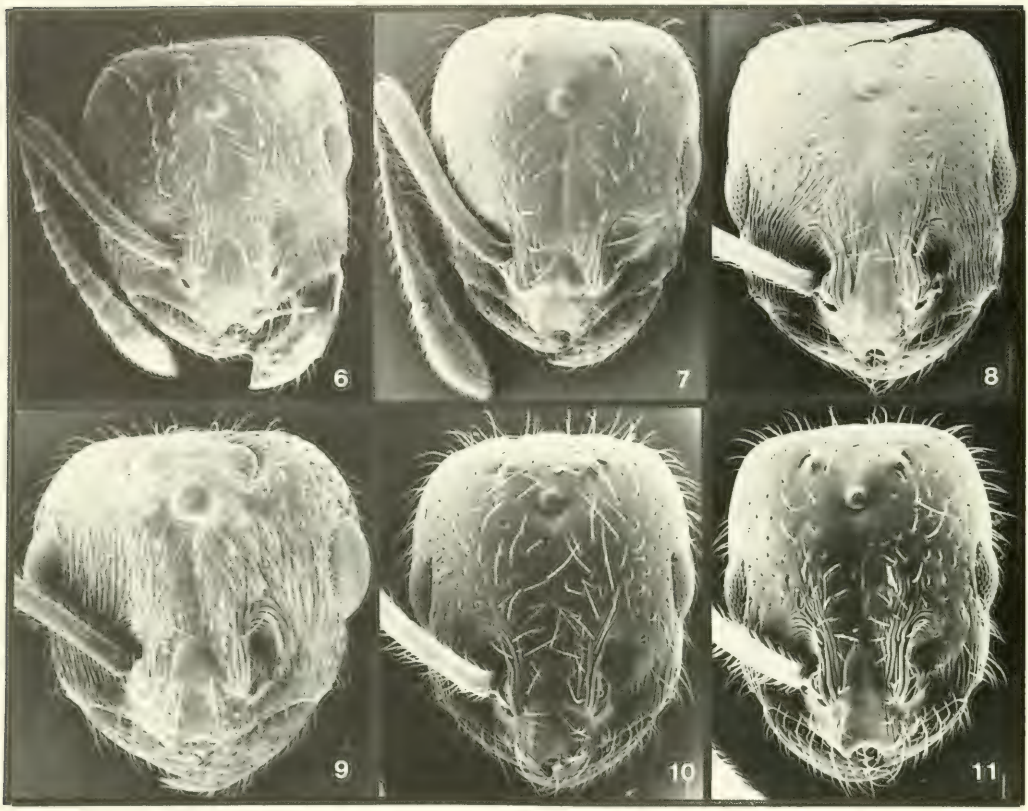
Most studies of biology of the *minimum* group emphasized information useful in constructing higher classifications of ants. Recent studies dealt with larvae (Wheeler and Wheeler, 1955, 1960a, 1960b, 1973, 1976), chromosomes (Crozier, 1970, 1975), sting morphology (Kugler, 1978), and venom components (Jones et al., 1980, 1982).

INQUILINISM

Inquilinous relationships between two species are those in which a socially parasitic species spends its entire life cycle in nests of its host species (Wilson, 1971). Since the inquilines rely on their hosts for food and care of their brood, the worker caste is often lacking (no workers have ever been discovered in the North American inquilinous *Monomorium*). This relationship is sometimes called "permanent parasitism."

Three species of inquilinous *Monomorium* have been discovered in North America: *M. inquilinum* (known only from one locality in central Mexico), *M. pergandei* (known only from Washington, D.C.), and *M. talbotae* (known only from one locality in central Michigan). These species follow the distributional pattern of most inquilinous ants, being known only from isolated, limited areas.

These inquilines are remarkably similar in general morphology, presumably because of convergence. In *M. pergandei* and



FIGS. 6-11. *Monomorium* queens, heads, frontal views. Scanning electron microscope photographs. Some photographs enlarged more than others to aid in comparison; for actual dimensions, refer to text. 6—*M. minimum.* 7—*M. trageri.* 8—*M. ebenium.* 9—*M. viridum.* 10—*M. cyaneum.* 11—*M. wheelerorum.*

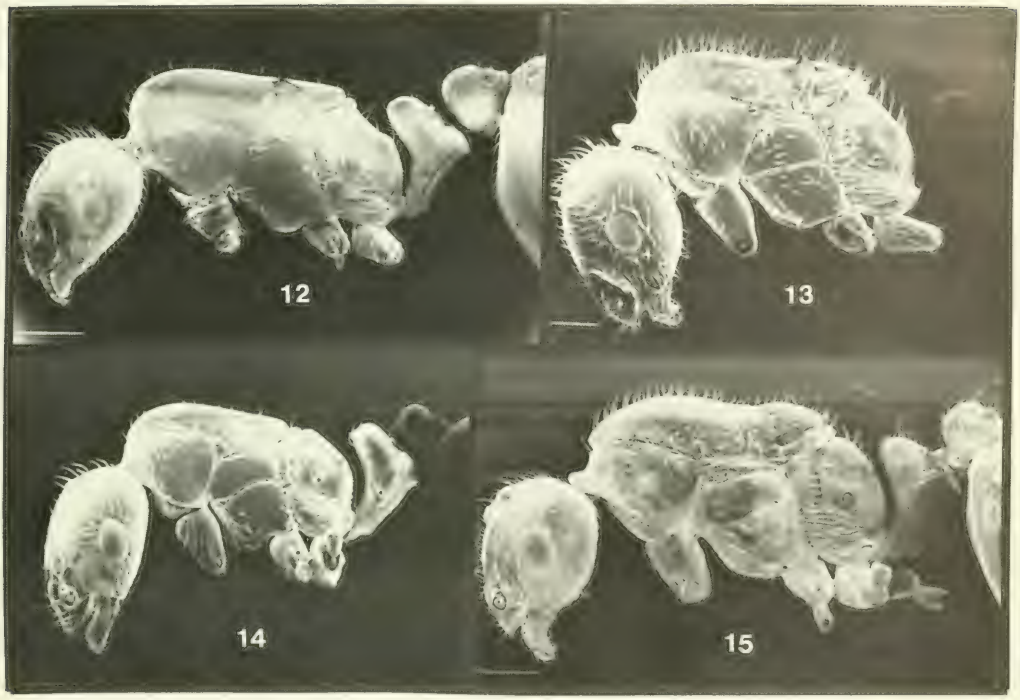
M. talbotae, males and females are quite similar to one another in overall morphology. In fact, the only method of determining gender is to examine their genitalia. This phenomenon has yet to be explained since non-inquilinous *Monomorium* have marked morphological differences between sexes.

DuBois (1981a) recognized the following common traits of inquilinous *Monomorium* (numbers of traits correspond to those of Wilson, 1971: 374-375): (1) the worker caste is absent, (4) both male and female are reduced in size, (8) venation in both forewing and hindwing is diluted — most 'veins' in forewing are represented as absence of microtrichia; hindwing venation is equally diminished, (9) mouthparts are reduced, (13) petiole and postpetiole are thickened, (14) ventral surface of postpetiole becomes armed with a spine, and (16) cuticular sculpturing is reduced. One additional character, probably associated with diminished size, is reduction in size and complexity of male genitalia (DuBois, 1981a).

Fossil History

Although genus *Monomorium* is represented in the fossil record by two species, *M. mayrianum* Wheeler and *M. pilipes* Mayr, both species are known only as workers in Baltic Amber (Wheeler, 1914a; Burnham, 1978). No fossil *Monomorium* have been discovered in North America (see, for example, Carpenter, 1930; Brown, 1973; Burnham, 1978).

Neither fossil species appears to be closely related to native North American *Monomorium. Monomorium mayrianum* has 5



FIGS. 12-15. *Monomorium* queens, lateral views (gasters and legs excluded). Scanning electron microscope photographs. Some photographs enlarged more than others to aid in comparison; for actual dimensions, refer to text. 12—*M. minimum.* 13—*M. cyaneum.* 14—*M. ebenium.* 15—*M. viridum.*

mandibular teeth, 12-jointed (segmented?) antenna, and a deep metanotal sulcus (Wheeler, 1914). *Monomorium pilipes* has 11-jointed (segmented?) antenna, and (probably) 5 mandibular teeth based on Wheeler's (1914a) description and accompanying figure.

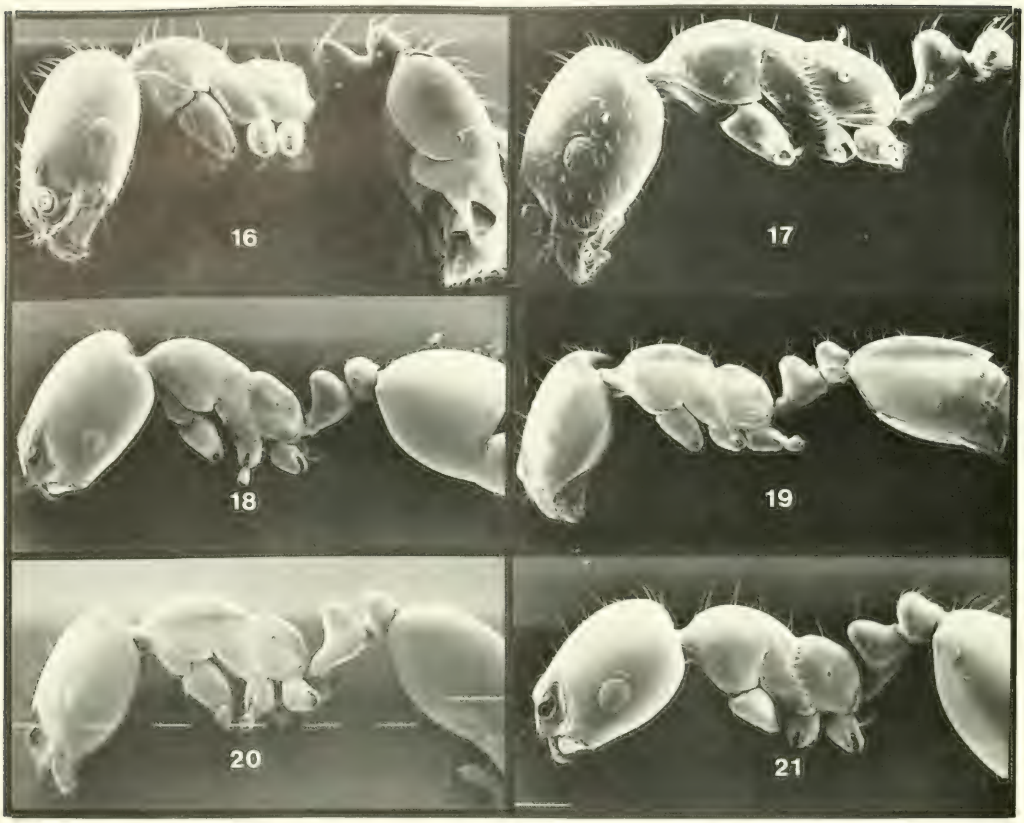
General Methods

As specimens were received, they were sorted into morphologically distinct groups; each group was compared with specimens previously received. These "morphospecies" were segregated with no effort to name each taxon due to prevailing confusion in the systematics of this group. When the majority of specimens was assembled, collection localities were plotted on a map to ascertain which geographic areas lacked representatitives. Efforts were then made (by contacting individuals or institutions in those regions) to cover deficient areas. Finally, names were assigned to taxa after comparison with type material or with descriptions when types were not readily available.

When possible, an effort was made to assign previously recorded information to one species or another. A reference is listed in synonymy if either one of two criteria is met: (1) a specimen from that study was examined and identified by me, or (2) the literature reference in question referred to an area where only one species of *Monomorium* probably occurs naturally. Obviously, this latter criterion is the weaker of the two.

Terminology

Most terms used are conventional to hymenopteran systematics and were defined by Snodgrass (1935, 1941). Some special terms, although known to myrmecologists, may cause difficulty; these have been listed below to clarify their use within this publication. Most of these terms have been used previously in revisions of other ant taxa (see, for example, Snelling,



FIGS. 16-21. *Monomorium* workers, lateral views (gasters and legs excluded). Scanning electron microscope photographs. Some photographs enlarged more than others to aid in comparison; for actual dimensions, refer to text. 16—*M. ebenium.* 17—*M. wheelerorum.* 18—*M. ergatogyna.* 19—*M. minimum.* 20—*M. trageri.* 21—*M. viridum.*

1976; Ettershank, 1966). Terms are listed in the order they appear within descriptions.

1. *Head length* (HL). Maximum length of head (in full face view), measured from midpoint of occipital margin to midpoint of anterior clypeal margin (Fig. 22, no. 1).

2. *Head width* (HW). Maximum width of head (excluding compound eyes) (Fig. 22, no. 2).

3. *Scape length* (SL). Maximum length of scape (excluding basal radicle) (Fig. 22, no. 3).

4. *Interocellar distance* (IOD). Queen and male only; minimum distance between inner margins of posterior ocelli, measured from dorsal view (Fig. 22, no. 4).

5. *Ocellar diameter* (OD). Queen and male only; maximum diameter of anterior ocellus (Fig. 22, no. 5).

6. *Eye length* (EL). Maximum length of compound eye, measured from lateral view (Fig. 22, no. 6).

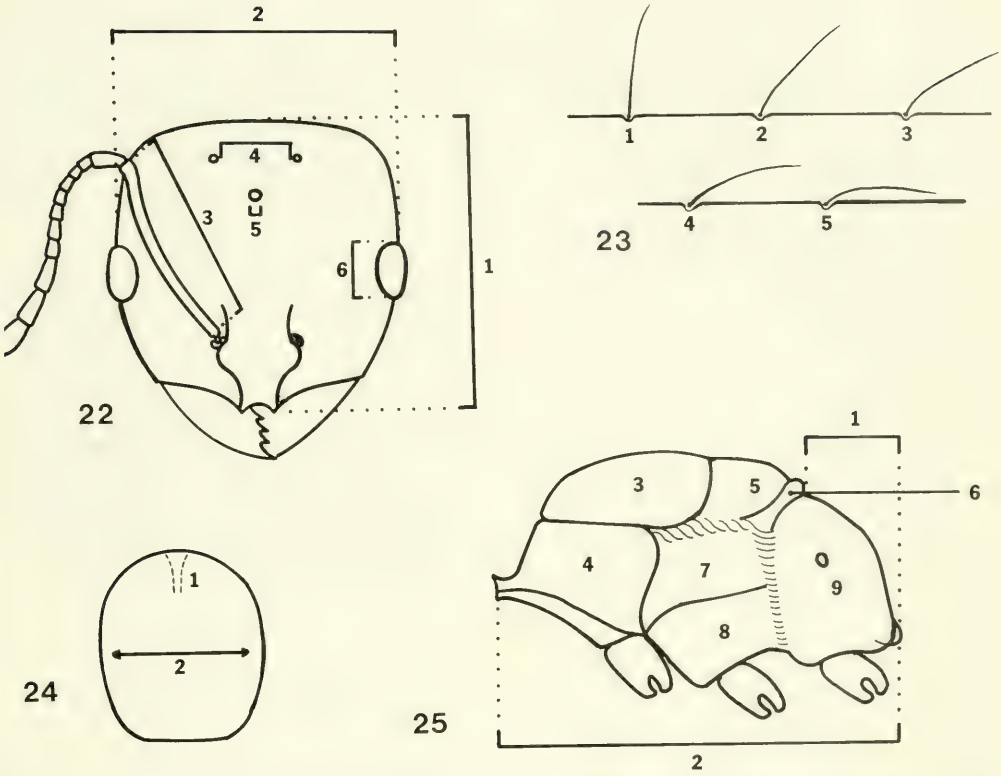
7. *Maximum ocular diameter* (MOD). Maximum width of compound eye, measured from lateral view.

8. *Cephalic index* (CI). Head width X 100 / head length.

9. *Scape index length comparison* (SIL). Scape length X 100 / head length.

10. *Scape index width comparison* (SIW). Scape length X 100 / head width.

11. *Pilosity.* Setal terminology used to indicate degrees of inclination following Wilson (1955) including following terms: (1) erect, (2) suberect, (3) subdecumbent, (4) decumbent, and (5) appressed (Fig. 23). Since these terms are discontinuous expressions of a continuous variable, the two extremes are used to delimit variation (for example,



FIGS. 22-25. Terminology. *Fig. 22.* Frontal view of head, generalized to show measurements. Numbers refer to following measurements: 1—head length, 2—head width, 3—scape length, 4—interocellar distance, 5 - ocellar diameter, 6—eye length. *Fig. 23.* Schematic representation of terminology of angle of declination of vestiture (after Wilson 1955). Numbers represent following declinations: 1—erect, 2—suberect, 3—subdecumbent, 4—decumbent, 5—appressed. *Fig. 24.* Dorsal view of scutum. 1—mesonotal furrow, 2—measurement of pronotal width (pronotum extends laterally along alitrunk and is usually the widest directly underneath this part of the scutum; refer also to Figure 25, number 4). *Fig. 25.* Lateral view of queen alitrunk. 1—propodeal length, 2—Weber's length (actual measurements are taken at a slight diagonal from front to rear instead of in a horizontal line as figure indicates), 3—scutum, 4—pronotum, 5—scutellum, 6—metanotum, 7—anepisternum, 8—katepisternum, 9—propodeum. Further explanations are provided in text.

setae erect to subdecumbent). First term used denotes most common inclination of setae on a given structure.

12. *Sculpture.* Usually reflected in terms of punctation or rugosity (see below). When surfaces are described as smooth and shining, this is their appearance at magnifications of 80X or lower; all cuticular surfaces appear rough at higher magnifications.

13. *Punctation.* Punctures can be piliferous (with setae) or non-piliferous (without setae). Sizes are given in relation to average diameter of one eye ommatidium. Select 5 ommatidia from the central portion of the compound eye and average their diameters. Small punctures are smaller than the average diameter of an ommatidium, moderate punctures are approximately the same diameter, and large punctures are larger than the average diameter.

14. *Rugosity.* Size as for punctation except size is measured as distance between two consecutive ridge summits (i.e., width of one trough).

15. *Pronotal width* (PW). Maximum width of pronotum, measured dorsally, perpendicular to longitudinal axis of thorax.

16. *Propodeal length* (PL). Maximum length of propodeum measured along longitudinal

axis of body from metanotum to apex of inferior propodeal plates (Fig. 25, no. 1).
17. *Weber's length* (WL). Maximum length of alitrunk, measured diagonally from dorsal margin of pronotal collar to apex of inferior propodeal plate (Fig. 25, no. 2).
18. *Propodeal index* (PI). Propodeal length X 100/Weber's length.
19. *Color.* Although all taxa examined appear piceous black at low magnifications, color refers to coloration observed at magnifications of 30X and above under florescent lighting. Many of the specimens examined have faded with age; hence, the colors in fresh specimens may be darker than indicated in the descriptions.

MEASUREMENTS

All measurements were made from dry, mounted specimens; most measurements were made at 80X magnification. Measurements were made with an ocular micrometer (100 units), converted to millimeters, and rounded to the nearest 0.01 mm. Where possible, these measurements were made from individuals (selected at random) from different localities (one individual per locality). All measurements are expressed as range and mean (mean in parentheses) with a maximum sample size of 10 per caste. Initial measurements (including mean, standard deviation, median, minimum value, maximum value, and correlation coefficients) are listed in DuBois (1981c).

Although both indexes involving scape length are listed for each species, it appears that the scape length to head length index is slightly more reliable; these indexes are closely correlated (most species $r = 0.900$ or greater). Since previous authors have employed either index in various revisions (cf. Francoeur, 1973; Snelling, 1976), both indices are included for comparative purposes.

Several steps were taken to avoid as many errors as possible. First, no measurements were recorded until I was able to obtain like measurements of the same structure on the same specimen on different days. Second, after measurements were taken, a number were selected (at random) and repeated. If the values differed for a given specimen, additional measurements were taken until an agreement was reached. Third, all measurements used in statistical analyses were checked against the original data sheets in search of typographical errors. Similarly, the final manuscript was checked against original data sheets.

SPECIES DESCRIPTION FORMAT

Descriptive features pertaining to holotype only are surrounded by brackets {} (with the exception of *M. inquilinum,* which is only known from the holotype). Features which rarely occur in a species are surrounded by the following symbols ›‹. If specimens are probably typical, overlook information within these symbols.

ORIENTATION

Specimens should be oriented in the same manner I examined them when describing a species. The head (excluding gular region and compound eye measurements) should always be examined in full frontal view. This is particularly true when examining setae, since their degree of inclination sometimes changes when viewpoint is radically changed. The gular region, compound eye measurements, alitrunk, petiole, postpetiole (excluding their dorsa), and gaster should be examined in lateral view. Both petiolar and postpetiolar dorsa should be examined by looking over the posterior end of the gaster, up the gastral dorsum.

DISSECTIONS

The following structures must be dissected before features can be observed: wings, male mouthparts, and male genitalia.

Wings — Most wings curl around their longitudinal axes in pinned specimens. Furthermore, wing venation is difficult to observe in specimens preserved in alcohol. Therefore, wings were removed, placed on a microscope slide, smoothed out, covered with a cover slip, and affixed to the slide with tiny droplets of mounting medium on corners of the cover slip. Since the mounting medium has nearly the same refractive

index as the wing itself, venation is nearly invisible if the entire wing is immersed in the medium. Venation in all species examined is fairly uniform; therefore, one example is depicted (*M. ergatogyna,* Fig. 71).

Male mouthparts — Mouthparts of males were selected for detailed study, since they are used less than queen and worker mouthparts. Additionally, female mouthparts are less variable among species. Mouthparts (labial palp, maxillary palp, and mandible) were examined in glycerine at 400X; illustrations were made using an ocular grid.

Male genitalia — The male genital capsule was removed entirely (after being drawn *in situ*) and dissected so that individual parts could be examined (examinations and illustrations same as for mouthparts). The eighth and ninth sterna were examined (in glycerine) after being flattened by a cover slip.

Preservation of Specimens

Due to their small size, most specimens should be preserved in alcohol. If necessary (for detailed examination) a subset can be pinned on points. Although the legs of the right side should be pushed into the glue, the entire body should never contact glue as the glue may spread by capillary action between setae and obscure details on the body.

Computer Techniques

Preliminary data analysis was conducted using MINITAB statistics programs which were run on the University of Kansas Academic Computer Center's Honeywell 66/60 computer.

Reference Collections

Specimens examined during this revision were borrowed from the following individuals and institutions (abbreviations are those used in listing localities). I am extremely grateful to those who cooperated by sending specimens.

AFPC—Andre Francoeur, personal collection

AMNH—American Museum of Natural History, New York (Marjorie Favreau)

BPPC—B. Poldi, personal collection (Mantova, Italy)

CAS—California Academy of Sciences, San Francisco (Paul Arnaud, Jr.)

CGPC—Chris George, personal collection

GCWPC—George C. and Jeanette Wheeler, personal collection

INHS—Illinois Natural History Survey, Urbana (Wallace LaBerge)

JMPC—James Moody, personal collection

JTPC—James Trager, personal collection

KSU—Kansas State University, Manhattan (Jim Johnson)

KU—Snow Entomological Museum, University of Kansas, Lawrence (George Byers)

LACM—Natural History Museum of Los Angeles County (Roy Snelling)

MBDPC—Mark DuBois, personal collection

MCZ—Museum of Comparative Zoology, Cambridge, Massachusetts (Margaret Thayer and Ron McGinley)

MHNG—Museum d'Histoire Naturelle, Geneva, Switzerland (Claude Besuchet)

MTPC—Mary Talbot, personal collection

NCSU—North Carolina State University, Raleigh (C. Parron)

NMNH—National Museum of Natural History, Washington, D.C. (David Smith)

OHSU—Ohio State University, Columbus (R. Triplehorn)

ORSU—Oregon State University, Corvalis (Gary Stonedahl)

OSU—Oklahoma State University, Stillwater (W. Drew)

PWPC—Petr Werner, personal collection (Prague, Czechoslovakia)

RHPC—Robert Hamton, personal collection

SBMNH—Santa Barbara Museum of Natural History, California (Scott Miller)

SBSK—State Biological Survey of Kansas, Lawrence (Mark DuBois)

UA—University of Arkansas, Fayetteville (Sheila Hoelscher)
UM—University of Missouri, Columbia (Edward Riley)
UN—University of Nebraska, Lincoln (Brett Ratcliffe)
UO—University of Oklahoma, Norman (Bill Shepard)

KEY TO QUEENS

1. Head broadest at occiput; surface sculpturing greatly reduced; masticatory margin of mandible with fewer than 4 teeth 11

   Head broadest near compound eyes; at least some surface sculpturing near mandibular insertion; masticatory margin of mandible with 4 teeth . . 2

2. (1). Lateral profile of scutum and scutellum convex (Figure 43). 5

   Lateral profile of scutum and scutellum flat or concave (Fig. 87) 3

3. (2). Scape with lateral fringe of erect setae (Fig. 82); occurs in California, Nevada, and Utah . . . *M. wheelerorum*

   Scape lacking lateral fringe of erect setae 4

4. (3). Petiole emarginate; postpetiole not emarginate; head sculpturing reduced (Fig. 120); occurs in Caribbean region . . . . . *M. ebenium*

   Petiole not emarginate; postpetiole emarginate; head sculpturing as in Fig. 88; occurs in central Mexico . . . . . *M. compressum*

5. (2). Mesonotum with notal furrow (Fig. 24, no. 1) 6

   Mesonotum lacking notal furrow . . 7

6. (5). Metanotum not projecting to level of propodeum and scutellum; petiole and postpetiole not emarginate; occurs in central and north-central Atlantic coastal states . . . . . *M. emarginatum*

   Metanotum projecting to level of propodeum and scutellum; petiole and postpetiole emarginate; occurs along coastal regions from New Jersey to Florida . . . . . *M. viridum*

7. (5). Scape with lateral fringe of erect setae (Fig. 59); occurs in coastal and southern California. . . . *M. ergatogyna*

   Scape lacking lateral fringe of erect setae 8

8. (7). Basal face of propodeum 2X length of declivity; known only from type locality (Nayarit, Mexico) *M. marjoriae*

   Basal face of propodeum never 2X length of declivity 9

9. (8). Head sculpturing greatly reduced, rugae only on lateral margin of clypeus; occurs in northern Florida. . . . . *M. trageri*

   Head with rugae in addition to those on lateral margin of clypeus. 10

10. (9). Gyne winged (sclerites near wing base not fused); postpetiole emarginate; common in central U.S. . . . . *M. minimum*

    Gyne wingless (sclerites fused); postpetiole not emarginate; occurs throughout central Mexico, Arizona, New Mexico, and parts of Texas . . . . . *M. cyaneum*

11. (1). Metanotum reaching level of propodeum and scutellum; postpetiole emarginate 12

    Metanotum not reaching level of propodeum and scutellum; postpetiole not emarginate; known only from type locality (Livingston Co., Michigan) . . . . . *M. talbotae*

12. (11). Mesonotum with notal furrow; petiole not emarginate; masticatory margin of mandible with 3 teeth; known only from type locality (Washington, D.C.). . . . . *M. pergandei*

    Mesonotum lacking notal furrow; petiole emarginate; masticatory margin of mandible with 2 teeth; known only from type locality (Estado de Mexico, Mexico) . . . . . *M. inquilinum*

KEY TO KNOWN MALES

The following species are not included in this key: *M. compressum, M. emarginatum, M. inquilinum, M. marjoriae, M. pergandei,* and *M. wheelerorum.*

1. Eighth sternite emargination lacking

projecting setae 2

Eighth sternite emargination with projecting setae; common along Atlantic coast from New Jersey to Florida . . . . . *M. viridum*

2. (1). Aedeagus with toothed margin straight 3

Aedeagus with toothed margin curved 4

3. (2). Cuspis of volsella present; known only from type locality (Livingston Co., Michigan). . . . . *M. talbotae*

Cuspis of volsella absent; occurs throughout Caribbean region . . . . . *M. ebeninum*

4. (2). Cuspis of volsella with 3 setae . 5

Cuspis of volsella with 5 setae; occurs throughout central Mexico, Arizona, New Mexico, and parts of Texas . . . . . *M. cyaneum*

5. (4). Aedeagus quadrate; occurs throughout central U.S. . *M. minimum*

Aedeagus longer than broad 6

6. (5). Eighth sternite emargination 1/2 as deep as wide (Fig. 74); occurs along California coast . . . . . *M. ergatogyna*

Eighth sternite emargination as deep as wide (Fig. 146); occurs in northern Florida. . . . . *M. trageri*

KEY TO KNOWN WORKERS

The following species are not included in this key and apparently lack a worker caste: *M. inquilinum, M. pergandei,* and *M. talbotae.*

1. Propodeum rounded (Fig. 63); occurs along California coast . . *M. ergatogyna*

Propodeum angular (Fig. 31). 2

2. (1). Basal and declivitous faces of propodeum of equal length 3

Basal and declivitous faces of propodeum of unequal length (either face may be longer). 5

3. (2). Mesopleuron punctate; fewer than 8 setae projecting above dorsum of alitrunk; occurs throughout central Mexico, Arizona, New Mexico, and parts of Texas . . . . . *M. cyaneum*

Mesopleuron not punctate; more than 10 (rarely 8 or 9) setae projecting above dorsum of alitrunk 4

4. (3). Petiole and postpetiole convex to flat; occurs in central Mexico . . . . . *M. compressum*

Petiole and postpetiole flat to slightly emarginate; occurs throughout Caribbean region . . . . . *M. ebeninum*

5. (3). Basal face of propodeum length less than declivity 6

Basal face of propodeum length greater than declivity. 7

6. (5). Fewer than 6 setae projecting above dorsum of alitrunk; occurs in northeastern U.S. . . . *M. emarginatum*

More than 8 setae projecting above dorsum of alitrunk; occurs in northern Florida. . . . . *M. trageri*

7. (5). Mesopleuron punctate; occurs along Atlantic coastline from New Jersey to Florida. . . . . *M. viridum*

Mesopleuron not punctate (for further separation of these species refer to their distributions) . . . . . *M. minimum, M. wheelerorum, M. marjoriae*

SYSTEMATIC TREATMENT

Genus *Monomorium* Mayr

A complete synonymy is provided by Ettershank (1966). The following synonymy contains only names pertaining to this revision. Similarly, complete synonymies are not provided for each species; only references of taxonomic or biological importance are listed.

Monomorium Mayr, 1855: 452. Type species: *Monomorium minutum* Mayr (Monobasic).
Epoecus Emery, 1892: cclxxvi-cclxxvii. Type species: *Epoecus pergandei* Emery (Monobasic).

DIAGNOSIS: QUEEN: Antenna 12- or 11-segmented, rarely 10-segmented, with more or less distinct club of greater than 2 segments; median clypeal setae always present; clypeus usually distinctly bicarinate, carinae sharp or rounded; propodeum never with distinct teeth, rarely angulate, usually rounded; petiole distinctly pedunculate; wing venation similar to that of *Solenopsis* but radial cell always open; metapleural gland well developed; four Malpighian tubules with tips attached to rectum

(cryptonephritic); diploid chromosome number usually 22. WORKER: Usually smaller than queen, remaining diagnosis same as queen, except wings lacking. MALE: Usually smaller than queen but larger than worker; Mayrian furrows lacking; mandible with teeth; antenna with 13 segments.

Subgenus *Monomorium* Mayr

Monomorium (Monomorium); Emery, 1921: 170.

DIAGNOSIS: QUEEN: Antenna 12-segmented with distinct 3-segmented club (lengths of club segments increasing distally); propodeum unarmed (small bump may be present); clypeus with carinae usually extended anteriorly into teeth; masticatory border of mandible with 2-5 teeth, usually 4. WORKER: As in queen; promesonotal suture reduced or absent; metanotal sulcus present as pronounced constriction. MALE: Antennal scape cylindrical, never surpassing occiput.

Monomorium (Monomorium) minimum species group

Monomorium species related to *M. minutum* Mayr, Emery, 1921: 171 (in part).

Monomorium minutum group, Ettershank, 1966: 83 (in part).

DIAGNOSIS: ALL CASTES: Anepisternum and katepisternum always smooth and shining; propodeum with distinct parallel longitudinal rugae on side.

This species group as here understood includes only those species which are native to North and Central America. Further revisionary work within this genus may reveal this to be a paraphyletic group and may show that certain South American and Asiatic species are members of this group. However, it is a group of species (somewhat isolated geographically) well suited for revisionary study.

Monomorium minimum (Buckley)

Figures 6, 12, 19, and 26-42

Myrmica (Monomarium) [sic] minima Buckley, 1867: 338.

Monomorium minutum var. *minimum:* Emery, 1895: 274-275 (in part); Wheeler, 1902: 27; Wheeler, 1908: 423 (in part).

Monomorium carbonarium: Mitchell and Pierce, 1912: 70 (misidentification).

Monomorium minimum: Wheeler, 1917a: 464-465, 501 (in part); Talbot, 1934: 420; Smith, 1935: 237; Smith, 1936a: 163; Cole, 1937: 99 (in part); Smith, 1943: 300; Buren, 1944: 289; Gregg, 1944: 456, 466; Smith, 1947: 565; Creighton, 1950: 219-222 (in part); Smith, 1952: 810 (in part); Cole, 1953: 299 (in part); Talbot, 1953: 4; Wheeler and Wheeler, 1955: 122; Kannowski, 1956: 177; Hess, 1958: 26-27; Smith, 1958: 128 (in part); Wheeler and Wheeler, 1960a: 15; Gregg, 1963: 367-368; Wheeler and Wheeler, 1963: 133-135 (in part); Smith, 1965: 33-34 (in part); Ettershank, 1966: 90 (in part); Smith, 1967: 356 (in part); Kempf, 1972: 144; Talbot, 1975: 245; Kugler, 1978: 451-452; Smith, 1979: 1382-1383 (in part); Talbot, 1979: 88; DuBois, 1981a: 33-34; DuBois, 1981b: 35; Jones *et al.*, 1982: 287.

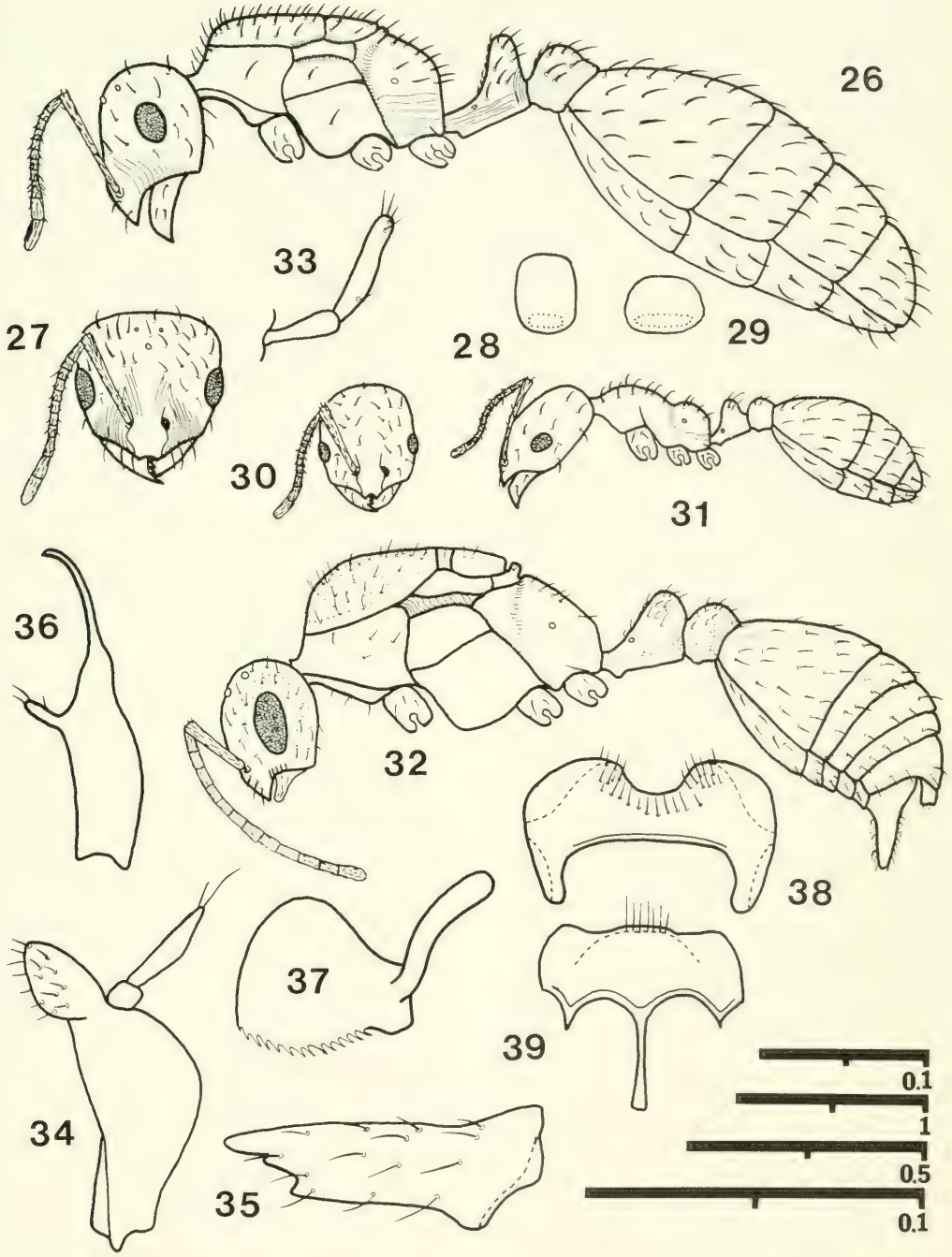
Monomorium minutum subsp. *minima:* Emery, 1921: 172 (in part).

Monomorium viridum peninsulatum: Creighton, 1950: 223-224 (in part), Gregg, 1963: 368-370 (misidentification); Smith, 1967: 356 (in part); Smith, 1979: 1384 (in part).

Monomorium metoecus Brown and Wilson, 1957: 239-244 (in part); Wilson and Brown, 1958: 33-38 (in part); Jones *et al.*, 1982: 287 (syn. by Brown in Ettershank, 1966: 90).

DIAGNOSIS. QUEEN: Winged; petiole as in Figures 26 and 28; scutum and scutellum not depressed; metanotum (in side view) projecting to level of propodeum and scutellum; propodeum angular. MALE: Genitalia and sterna as in Figures 32 and 36-39. WORKER: Propodeum angular; mesopleuron not punctate; petiole as in Figure 31; PI 33-40 (37).

DESCRIPTION. QUEEN: *HEAD: Measurements* (representing different localities; $N = 10$) {Neotype measurements in brackets} HL 0.69-0.86 (0.77) {0.79}, HW 0.65-0.81 (0.74) {0.66}, SL 0.40-0.60 (0.50) {0.58}, IOD 0.12-0.20 (0.17) {0.17}, OD 0.04-0.06 (0.05) {0.06}, EL 0.15-0.20 (0.17) {0.20}, MOD 0.11-0.18 (0.13) {0.15}. *Structure*—Head slightly longer than broad or slightly broader than long, CI 84-106 (95) {84}, distinctly longer than scape, SIL 56-79 (65) {73}; SIW 53-88 (68) {88}. In full frontal view, head broadest slightly above eyes; side convex; occiput rounded laterally, summit flat. Eye moderate in size. Scape reaching but never surpassing occiput. Mandible with 4 teeth; maxillary palp 2-segmented; labial palp 2-segmented. Clypeal teeth sharp, moderate in length. Frontal carinae diverging slightly posteriorly. *Pilosity*—Setae erect to suberect on clypeus, frons, gular region, mandible, and occiput, decumbent to appressed elsewhere.



FIGS. 26-39. *Monomorium minimum.* 26—Queen, lateral view. 27—Head of queen, frontal view. 28—Petiole of queen, posterior view. 29—Postpetiole of queen, posterior view. 30—Head of worker, frontal view. 31—Worker, lateral view. 32—Male, lateral view. 33—Labial palp of male. 34—Maxilla and maxillary palp of male. 35—Mandible of male. 36—Volsella of male. 37—Aedeagus of male. 38—Eighth sternite of male. 39—Ninth sternite of male. *Scales:* Top scale (0.1 mm) for Figure 35. Second scale (1 mm) for Figures 26-32. Third scale (0.5 mm) for Figures 36 and 37. Bottom scale (0.1 mm) for Figures 33 and 34.

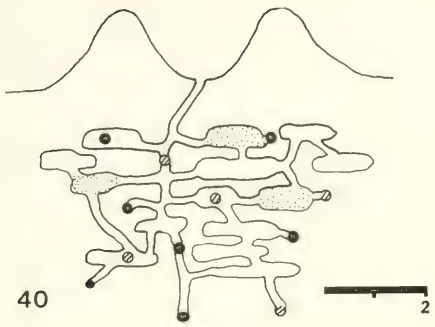
Setae of scape suberect to decumbent, of pedicel and flagellum decumbent to appressed with percentage of latter increasing distally. *Sculpture*—Head smooth and shining with small to moderate piliferous punctures evenly distributed except as follows: small, parallel, longitudinal rugosities beginning all along lateral margin of clypeus, extending past antennal insertion, converging with rugosities from frontal carinae and extending to level of anterior ocellus. Other small, parallel, longitudinal rugosities beginning between frontal carinae, sometimes extending to level of anterior ocellus (Fig 27). *ALITRUNK: Measurements* PW 0.50-0.72 (0.61) {0.62}, PL 0.31-0.42 (0.38) {0.40}, WL 1.34-1.81 (1.61) {1.37}. *Structure*—Mesonotum usually lacks notal furrow ›rarely, with small emargination‹. Pronotal-scutal suture on dorsal 1/3 of alitrunk. Scutum and scutellum not depressed. Mesopleural suture straight or deflected ventrally on posterior end and deflected dorsally on anterior end (resulting in S-shaped suture). Small pit usually present on posterior end of suture. Metanotum (in lateral view) reaching or exceeding level of propodeum and scutellum. Propodeum angular, basal face approximately 2/3 length of declivitous face. PI 21-29 (24) {29}. Wings present; venation typical (Fig. 71); 6-8 hamuli on hindwing; stigma located directly above vannal emargination {neotype lacks wings but condition of basal sclerites indicate queen once possessed wings}. *Pilosity*—Dorsal outline of alitrunk with more than 30 erect to suberect setae. Setae erect to suberect on coxae and trochanters, erect to suberect on flexor surfaces of femora (decumbent to appressed elsewhere), decumbent to appressed on tibiae and tarsi. *Sculpture*—Smooth and shining except as follows: moderate to large piliferous punctures on dorsum of alitrunk; lower 1/2 of side of propodeum (below spiracle) with several moderate, parallel, longitudinal rugae ›rarely, some rugae occur above spiracle‹; sculpturing of sutures as in Fig. 26. *PETIOLE:* As in Figures 26 and 28. Dorsum of node convex to flat. Subpetiolar process moderate in size, anterior to node. Setae decumbent to appressed on anterior surface, erect to suberect on dorsum, posterior surface, and side, absent from venter. Dorsum of node smooth and shining with moderate piliferous punctures; side with moderate, parallel, longitudinal rugae becoming transverse near posterior surface of node; posterior surface of node with moderate, semicircular, concentric rugae. *POSTPETIOLE:* As in Figures 26 and 29. Dorsum of node flat to slightly emarginate. Anterior subpostpetiolar process reduced, located medially on venter. Setae appressed to decumbent on anterior surface of node, suberect to erect on remaining surfaces. Dorsum of node smooth and shining with moderate to small piliferous punctures; remainder of node covered with dense, moderate to small, non-piliferous punctures. *GASTER:* Setae erect to decumbent on all surfaces with percentage of erect to suberect setae increasing towards posterior end of gaster. Setae of first gastral tergite exceeding level of dorsum of postpetiolar node. All surfaces smooth and shining with small to moderate piliferous punctures. *COLOR:* Head brown to dark brown with mandible and lateral margin of clypeus yellow brown to brown; scape brown, pedicel and flagellum yellow brown to yellow. Alitrunk brown to dark brown with legs brown; tibiae and tarsi yellow brown to yellow. Petiole, postpetiole, and gaster brown to dark brown. All setae white.

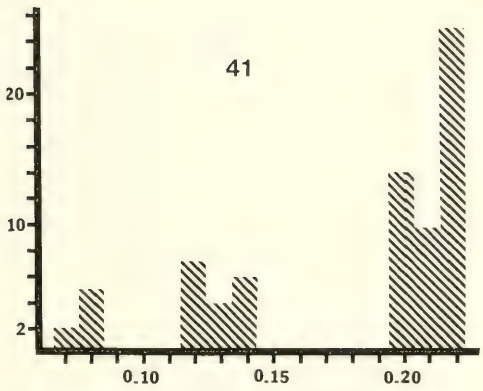
MALE: *HEAD: Measurements* (representing different localities; $N = 10$) HL 0.65-0.74 (0.71), HW 0.69-0.78 (0.75), SL 0.22-0.30 (0.26), IOD 0.22-0.26 (0.24), OD 0.05-0.12 (0.09), EL 0.28-0.34 (0.32), MOD 0.15-0.24 (0.19). *Structure*—Head slightly broader than long, CI 105-109 (107), distinctly longer than scape, SIL 31-42 (36); SIW 29-38 (34). In full frontal view, head broadest at or slightly above eyes; side straight to slightly convex (usually obscured by compound eye); occiput rounded laterally, summit flat (usually obscured by posterior ocelli). Eye large. Scape not reaching occiput. Mandible with 3 teeth; maxillary palp 2-segmented; labial palp 2-segmented. Clypeal teeth reduced or absent (blunt if present). Frontal carinae diverging slightly posteriorly. *Pilosity*—Setae erect to decumbent over entire surface of head with erect to suberect setae predominating near clypeus, gular region, mandible, and occiput. Antennal pilosity as in queen. *Sculpture*—Entire head covered with dense, moderate to large, non-piliferous punctures. Small to moderate, parallel, longitudinal rugae beginning all along lateral margin of clypeus, continuing to level of antennal insertion and fusing with large, concentric, semicircular rugae surrounding antennal insertion. *ALITRUNK: Measurements* PW 0.70-0.81 (0.76), PL 0.44-0.62 (0.52), WL 1.66-1.90 (1.75). *Structure*—Mesonotum lacking notal furrow. Pronotal-scutal suture on dorsal 1/3 of alitrunk. Scutum and scutellum not depressed. Mesopleural suture deflected ventrally at posterior end and deflected dorsally at anterior end (resulting in an S-shaped suture) with small pit on posterior end. Metanotum (in lateral view) reaching or exceeding level of propodeum and scutellum. Propodeum angular, basal face 2X as long as declivitous face.

Wings present; venation typical; 5-7 hamuli on hindwing; stigma located directly above vannal emargination. *Pilosity*—Dorsal outline of alitrunk with more than 30 erect to suberect setae; setae absent from side (except near sutures). Leg pilosity as in queen. *Sculpture*—Entire surface smooth and shining except as follows: small to moderate piliferous punctures on dorsum of alitrunk; small to moderate non-piliferous punctures loosely distributed on side; lower 1/2 of side of propodeum (below spiracle) with small, parallel, longitudinal rugae; entire surface of propodeum often covered with small, non-piliferous punctures (Fig. 32). *PETIOLE:* As in Figure 32. Dorsum of node flat to emarginate. Subpetiolar process reduced, anterior to node. Setae erect to decumbent on anterior surface of node, erect to suberect on side and posterior surface of node, absent elsewhere (including dorsum of node). All surfaces smooth and shining except as follows: small to moderate piliferous punctures on anterior and posterior surfaces of node; side with small to moderate non-piliferous punctures. *POSTPETIOLE:* As in Figure 32. Dorsum of node flat to slightly emarginate. Anterior subpostpetiolar process absent. Setae erect to decumbent on anterior surface, side, and posterior surface, absent elsewhere. Dorsum of node smooth and shining; remainder of node covered with moderately dense, non-piliferous punctures. *GASTER:* Pilosity as in queen. All surfaces smooth and shining with small to moderate piliferous punctures. *GENITALIA:* As in Figures 32 and 36-39. Eighth sternite with emargination lacking setae, approximately as deep as wide (Fig. 38). Ninth sternite with 6-8 erect setae (Fig. 39). Aedeagus with 12-15 teeth; toothed margin rounded (Fig. 37). Volsella with curved digitus and reduced cuspis; cuspis with 3 setae (Fig. 36). *COLOR:* Head brown to dark brown, mandible and lateral margin of clypeus yellow brown to yellow. Alitrunk brown to yellow brown; leg coloration as in queen. Petiole, postpetiole, and gaster brown to dark brown. Genitalia brown to yellow brown. All setae white.

WORKER. *HEAD: Measurements* (representing different localities; $N = 10$) HL 0.46-0.56 (0.52), HW 0.38-0.48 (0.42), SL 0.28-0.40 (0.33), EL 0.06-0.10 (0.09), MOD 0.05-0.08 (0.06). *Structure*—Head a little longer than broad, CI 76-86 (81), distinctly longer than scape SIL 56-71 (64); SIW 71-90 (79). In full frontal view, head broadest at or slightly above eyes; side convex; occiput rounded laterally, summit flat. Eye small in size. Scape never reaching occiput. Mandible with 4 teeth; maxillary palp 2-segmented; labial palp 2-segmented. Clypeal teeth sharp, of moderate length. Frontal carinae diverging slightly posteriorly ⟩rarely, parallel⟨. *Pilosity*—Setae suberect to subdecumbent on clypeus, frons, gular region, mandible, and occiput, decumbent to appressed elsewhere. Setae of scape subdecumbent to decumbent, of pedicel and flagellum decumbent to appressed. *Sculpture*—All surfaces smooth and shining with small to moderate piliferous punctures. *ALITRUNK: Measurements* PW 0.22-0.32 (0.28), PL 0.18-0.25 (0.21), WL 0.50-0.65 (0.57). *Structure*—Mesonotum lacking notal furrow. Anterior propodeal suture of moderate depth. Propodeum angular, basal face 1.5-2X as long as declivitous face. PI 33-40 (37). *Pilosity*—Dorsal outline of alitrunk with more than 10 erect to suberect setae. Leg pilosity as in queen. *Sculpture*—Entire surface smooth and shining except as follows: small to moderate piliferous punctures on dorsum; lower 1/2 of side of propodeum (below spiracle) with 1-3 small, parallel, longitudinal rugae. *PETIOLE:* As in Figure 31. Dorsum of node convex. Subpetiolar process of moderate to reduced size, anterior to node. Setae erect to suberect on dorsum, absent elsewhere. All surfaces smooth and shining with small piliferous punctures on dorsum. *POSTPETIOLE:* As in Figure 31. Dorsum of node convex. Anterior subpostpetiolar process reduced, located medially on venter. Setae suberect to erect on dorsum, absent elsewhere. All surfaces smooth and shining with small piliferous punctures on dorsum. *GASTER:* Setae erect to suberect with percentage of erect setae increasing towards posterior end of gaster. Setae of first gastral tergite not exceeding level of dorsum of postpetiolar node. All surfaces smooth and shining with small to moderate piliferous punctures evenly distributed. *COLOR:* Head brown to dark brown with trace of bluish reflection, mandible yellow brown to yellow. Alitrunk brown to dark brown with trace of bluish reflection, legs yellow brown with tibiae and tarsi yellow. Petiole, postpetiole, and gaster brown. All setae white.

TYPE MATERIAL. None known to exist (Creighton, 1950). Wheeler (1902) stated the probable type locality as Austin, Texas (or vicinity) since Buckley (1867) failed to mention a specific locality. Although a few of Buckley's specimens remain (Academy of Natural Sciences, Philadelphia and collection of Gustav Mayr, Vienna Museum of Natural History, Vienna, Austria), none could be located that were collected in the





FIGS. 40-41. *Monomorium minimum.* 40—Diagrammatic lateral view of nest. Darkened circles represent tunnels leading away from viewer. Cross-hatched circles represent tunnels leading toward viewer. Stippled chambers represent chambers containing queens and brood. *Scale*=2 mm. 41—Histogram of larval head widths in one nest. Interval is 0.10 mm.

1860's or earlier which might have provided the basis for his description.

Since two species of *Monomorium, M. cyaneum* and *M. minimum,* could occur in the Austin, Texas, vicinity, I designate the following queen [MCZ] as neotype of *Monomorium minimum* to reduce confusion: *TEXAS:* Bastrop Co., Bastrop State Park, June 9, 1954, W. Clayd T-119. Since Buckley failed to mention a specific locality in his original description, I followed Wheeler's suggestion in designating a neotype from the Austin, Texas, vicinity. This specimen bears a red, handwritten label: *Monomorium/ minimum/* (Buckley)/ Neotype/ M. DuBois 1983/.

DISTRIBUTION. This species ranges from Pennsylvania and District of Columbia, south to Georgia, west to Texas and New Mexico, and north to Idaho, Montana, and North Dakota (Fig. 42). Although this species has been collected in northern Wisconsin and North Dakota, no collections have been made in southern Canada; this species undoubtedly occurs there. In the eastern United States, this species occurs sporadically and is apparently replaced by *M. emarginatum* in the northeastern states and by *M. viridum* along the Atlantic coast in New Jersey, Georgia, and Florida. In the southern United States, *M. minimum* is known from collections in northern Georgia (Athens), Alabama (northern Alabama south to Mobile), Mississippi (only two collections, Amory and State College), and numerous collections in Louisiana and Texas. This species overlaps the range of *M. cyaneum* in Texas and New Mexico. *Monomorium cyaneum* apparently prefers drier habitats and usually nests under rocks while *M. minimum* prefers moisture habitats usually near the edges of woods. Most of my records of *M. minimum* from Colorado are from the eastern plains. I have only examined one worker which was collected from western Colorado (Mesa Verde National Park). However, Gregg (1963) includes many localities from the mountainous regions of the state (his *M. viridum peninsulatum* records should be included with his records for *M. minimum*). The furthest western records for *M. minimum* are three collections from southern Idaho (Rupert, 6.4 km W of St. Anthony, and Holbrook). These three collections consist of workers only. It is possible these are *M. wheelerorum* although they appear to be *M. minimum* workers. A detailed list of all localities for this and other *Monomorium* species is provided in DuBois (1981c).

DISCUSSION. BIOLOGY. Recorded as nesting in soil, under rocks, in logs, man-made structures, and living trees (mesquite, *Prosopis glandulosa*) (Dennis, 1938; Buren, 1944; Kannowski, 1956; Hess, 1958; Wheeler and Wheeler, 1963). Talbot (1934) and Gregg (1944) found *M. minimum* most frequently in sandy soil, and

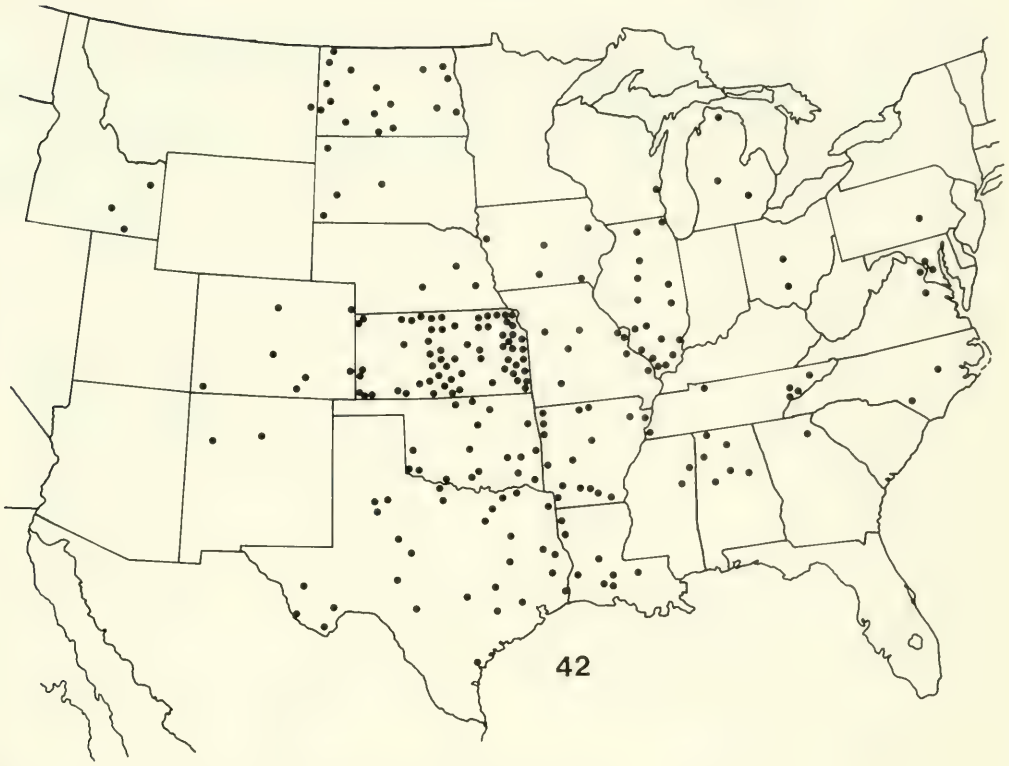


FIG. 42 Distribution of *Monomorium minimum* (closed circles).

Gregg (1963) discovered it in a number of microhabitats representing both Upper Sonoran and Transition life zones: foothills meadow, deciduous canyon forest, oak woodland, ponderosa pine-oak woodland, pinyon-cedar woodland, pinyon-cedar-oak woodland, mixed grass prairie, short grass prairie, sagebrush desert, sagebrush-greasewood desert, sandhills grassland, roadside, and exposed bedrock.

Nests in soil appear to have a characteristic structure; most are shallow (less than 10 cm deep, Kannowski, 1956) with most brood chambers located from just under the soil surface to depths of 5 cm (Wheeler and Wheeler, 1963). Although this description referred to nests in North Dakota, nests in Kansas and Illinois are of a similar internal construction (Fig. 40). However, tumuli vary considerably depending upon environmental conditions. In Kansas, most nests are located near edges of woodlands and have tumuli with a typical crater structure such as that depicted in Figure 40. Nests in areas of scant vegetation usually lack conspicuous tumuli, since soil particles are presumably blown away as soon as they are deposited on the surface. Nests in sheltered areas, such as at the base of grass clumps, possess mounds with many crenulations causing the structure to resemble a lump of brain coral.

In addition to the wide environmental tolerance of this species, there is a wide altitudinal tolerance. In Kansas, collection elevations range from 244 m to over 1220 m (pers. observ.). In Colorado, Gregg (1963) found collection elevations to range from 1067 m through 2591 m. Similar elevational extremes were found in Tennessee by Dennis (1938). This species also occurs down to sea level.

Monomorium minimum queens live approximately 1 year in laboratory colonies while workers live approximately 4 months. There appear to be three larval instars (Fig. 41) (pers. observ.).

Most nests contain multiple queens. For

example, Gregg (1944) found that nests near Chicago, Illinois usually contained 12-14 queens and Dennis (1938) found a similar number of queens per nest in Tennessee. Presumably these are functioning queens since most are associated with small, separate piles of eggs and first instar larvae (pers. observ.). Recent preliminary allozyme studies have demonstrated that several queens produce eggs at the same time in nests near Lawrence, Kansas (pers. observ.). Although it is not known how many queens establish a nest, most nests are probably established by one or two queens since a number of small nests with a small number of offspring and one or two queens are found each autumn in the Lawrence, Kansas, vicinity. Since nuptial flights occur in July in this vicinity, most newly mated queens should have new nests established by autumn.

Production of sexuals occurs in late spring and summer; most nests in Kansas contain larvae which will develop into sexuals by late May. Most sexual adults eclose by mid-July. Nuptual flights have not been observed, although they probably occur, since both males and gynes are winged.

Monomorium minimum is one of two species reported to have inquilines (*M. ergatogyna* is the other species). Van Pelt and Van Pelt (1972) reported larvae of *Microdon baliopterus* Loew (Diptera: Syrphidae) from nests of *M. minimum* in Big Bend National Park, Texas.

Monomorium minimum nests have been discovered in close association with nests of other ant species. Wheeler and Wheeler (1963) found *M. minimum* associated with nests of the following species: *Acanthomyops claviger* (Roger), *Camponotus vicinus* Mayr, *Formica fusca* Linnaeus, *Lasius crypticus* Wilson, and *Pogonomyrmex occidentalis* (Cresson). I have found nests of *M. minimum* associated with nests of an additional species, *Solenopsis (Diplorhoptrum) molesta* (Say), in Kansas.

COMPARISONS. Since *Monomorium minimum* queens are winged, they can easily be separated from other species occurring in the same area, most of which have wingless queens. Only *M. viridum* queens are winged. Nests of *M. viridum* appear to be restricted to pure sand while nests of *M. minimum* only occur in soils containing some clay (W. L. Brown pers. observ.). Workers of this species can usually be separated by the combination of characters listed in the diagnosis, particularly the smooth and shining mesopleuron.

Monomorium cyaneum Wheeler

Figures 10, 13, and 43-57

Monomorium minimum: Wheeler, 1906: 332, 336 (misidentification); Wheeler, 1908: 423 (in part); Smith, 1936a: 163 (in part); Cole, 1937: 99 (in part); Creighton, 1950: 219 (in part); Cole, 1953: 299 (in part); Smith, 1958: 128 (in part); Ettershank, 1966: 90 (in part); Smith, 1967: 356 (in part); Hunt and Snelling, 1975: 21; Smith, 1979: 1382-1383 (in part).

Monomorium minimum subsp. *cyaneum* Wheeler, 1914b: 43; Wheeler, 1917a: 465, 501; Kempf, 1972: 144.

Monomorium minutum subsp. *minima* var. *cyanea:* Emery, 1921: 173.

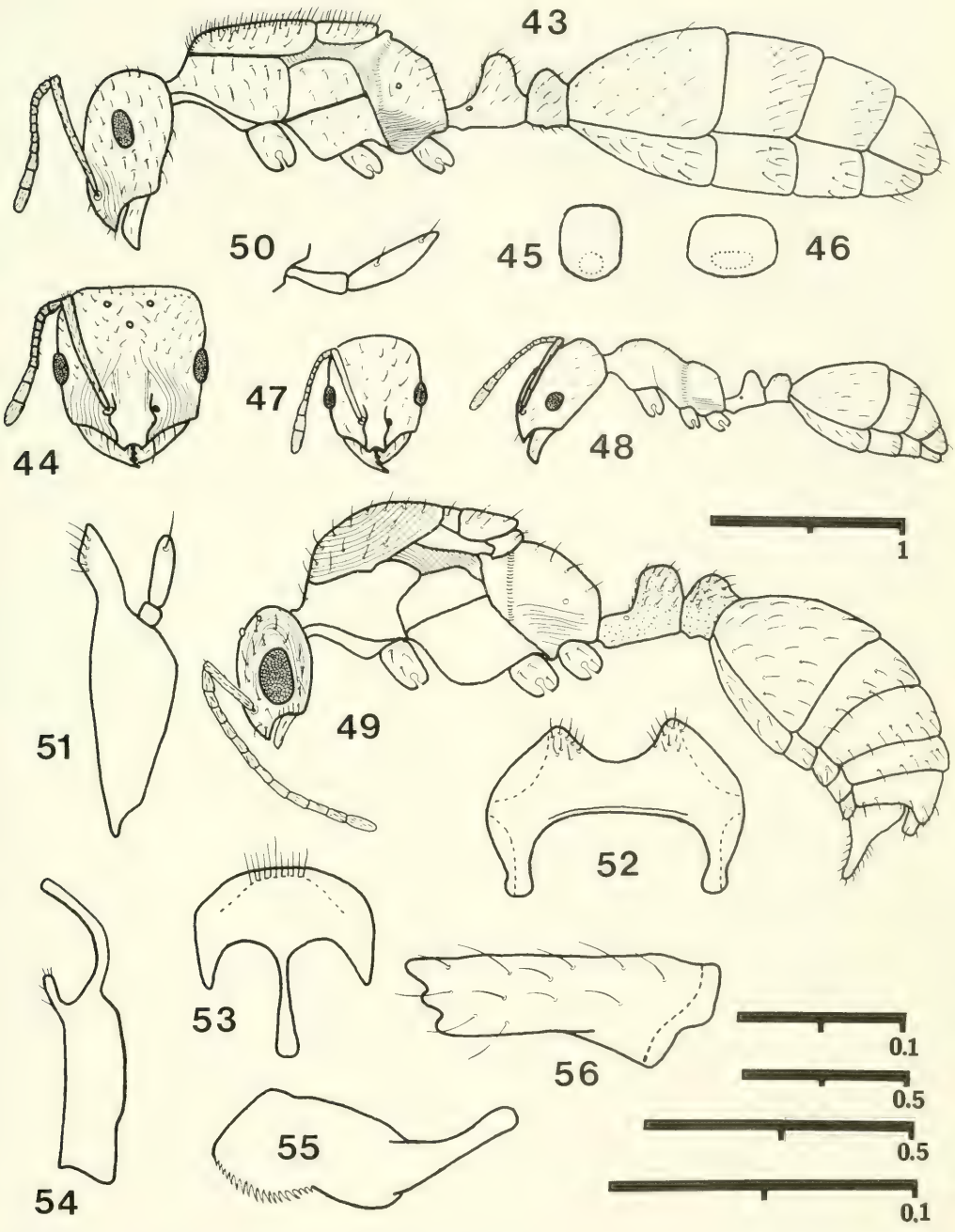
Monomorium minimum subsp. *emersoni* Gregg, 1945: 66-67; Smith, 1952: 810 (in part); *NEW SYNONYMY.*

Monomorium cyaneum: Ettershank, 1966: 88; DuBois, 1981a: 35-36; Jones et al., 1982: 287.

Monomorium near *emersoni:* Jones et al., 1982: 287.

DIAGNOSIS. QUEEN: Wingless; scutum and scutellum not depressed; metanotum (in lateral view) projecting to level of propodeum and scutellum; propodeum angular; petiole as in Figures 43 and 45; head sculpturing as in Figure 44. MALE: Genitalia and sterna as in Figures 49, 52-55. WORKER: Propodeum angular; mesopleuron punctate; petiole as in Figure 48; PI 29-38 (34).

DESCRIPTION. As described for *M. minimum* except as indicated. QUEEN: *HEAD: Measurements* (representing different localities; $N=10$) HL 0.68-0.88 (0.76), HW 0.62-0.78 (0.68), SL 0.50-0.55 (0.52), IOD 0.15-0.19 (0.18), OD 0.04-0.05 (0.05), EL 0.16-0.20 (0.18), MOD 0.12-0.16 (0.13). *Structure*—CI 83-96 (90), SIL 62-76 (69), SIW 70-84 (77). Scape reaching or barely surpassing occiput. *Pilosity*—Setae suberect to subdecumbent near clypeus, frons, gular region, mandible, and occiput, decumbent to appressed elsewhere. *ALITRUNK: Measurements* PW 0.41-0.48 (0.44), PL 0.28-0.32 (0.30), WL 1.28-1.38 (1.32).



FIGS. 43-56. *Monomorium cyaneum.* 43—Queen, lateral view. 44—Head of queen, frontal view. 45—Petiole of queen, posterior view. 46—Postpetiole of queen, posterior view. 47—Head of worker, frontal view. 48—Worker, lateral view. 49—Male, lateral view. 50—Labial palp of male. 51—Maxilla and maxillary palp of male. 52—Eighth sternite of male. 53—Ninth sternite of male. 54—Volsella of male. 55—Aedeagus of male. 56—Mandible of male. *Scales:* Top scale (1 mm) for Figures 43-49. Second scale (0.1 mm) for Figure 56. Third scale (0.5 mm) for Figures 52 and 53. Fourth scale (0.5 mm) for Figures 54 and 55. Bottom scale (0.1 mm) for Figures 50 and 51.

Structure—Mesonotum lacking notal furrow. Mesopleural suture straight with no pits at either end. Propodeum angular, basal face half as long as declivitous face. PI 22-25 (23). Wings absent (fusion of sclerites and presence of callow queens in some nests indicate queens are wingless). *Pilosity*—Setae suberect to decumbent on side of alitrunk. *Sculpture*—Small to moderate piliferous punctures evenly distributed on alitrunk (moderate punctures predominating dorsally). *Petiole:* As in Figures 43 and 45: dorsum of node flat. Subpetiolar process reduced. Peduncle with dense, small, nonpiliferous punctures; remainder of petiole smooth and shining with small to moderate piliferous punctures evenly distributed on anterior surface, dorsum, posterior surface, and sides. *Postpetiole:* As in Figures 43 and 46: dorsum of node flat. Entire surface covered with dense, small to moderate, nonpiliferous punctures. *Gaster:* Setae of first gastral tergite not exceeding level of dorsum of postpetiolar node. *Color:* Mandible yellow to yellow brown. Alitrunk brown, legs yellow brown.

MALE: *Head: Measurements* (representing 1 locality, $N=1$) HL 0.68, HW 0.72, SL 0.26, IOD 0.24, OD 0.08, EL 0.30, MOD 0.17. *Structure*—CI 106, SIL 38, SIW 36. *Sculpture*—Occiput with several moderate to large, concentric, semicircular rugae. *Alitrunk: Measurements* PW 0.75, PL 0.49, WL 1.72. *Structure*—Mesopleural suture straight (pits lacking on both ends). Metanotum (in lateral view) not reaching level of propodeum and scutellum. *Pilosity*—Dorsal outline of alitrunk with fewer than 30 erect to suberect setae projecting above outline. *Sculpture*—Scutum with large, concentric, semicircular rugae. *Petiole:* As in Figure 49. Dorsum of node flat. Setae erect to subdecumbent on dorsum of node. Entire surface of node covered with small, non-piliferous punctures. *Postpetiole:* As in Figure 49. Anterior subpostpetiolar process reduced. Entire surface of node covered with small, non-piliferous punctures. *Gaster:* As in Figures 49, and 52-55. Ninth sternite with 11 setae (Fig. 53). Aedeagus with 18 teeth (Fig. 55). Cuspis of volsella with 5 setae (Fig. 54). *Color:* As in queen. Genitalia yellow brown.

WORKER. *Head: Measurements* (representing different localities; $N=10$) HL 0.48-0.60 (0.51), HW 0.35-0.42 (0.39), SL 0.30-0.45 (0.35), EL 0.08-0.10 (0.09), MOD 0.05-0.06 (0.05). *Structure*—CI 70-83 (78), SIL 60-80 (70), SIW 77-107 (90). *Pilosity*—Setae erect to suberect on clypeus, frons, gular region, mandible, and occiput, decumbent to appressed on remainder. *Alitrunk: Measurements* PW 0.20-0.25 (0.22), PL 0.14-0.22 (0.18), WL 0.45-0.62 (0.54). *Structure*—Propodeum angular, basal and declivitous faces of approximately equal length. *Pilosity*—Dorsal outline of alitrunk with 4-8 erect to suberect setae. *Sculpture*—Mesopleuron covered with small, dense, non-piliferous punctures (leading to a granular appearance); lower 1/3 of side of propodeum (below spiracle) with moderate, parallel, longitudinal rugae. PI 29-38 (34). *Petiole:* As in Figure 48. Dorsum of node flat to slightly convex. *Postpetiole:* As in Figure 48. Dorsum of node flat to slightly convex. Anterior subpetiolar process absent.

TYPE MATERIAL. Syntypic series consisting of "numerous workers and females" (Wheeler, 1914b): MEXICO: *Hidalgo:* Guerrero Mill [spring or summer, 1913], W. M. Mann (4 queens, 40 workers; NMNH). Lectotype queen here designated from NMNH series bears red, handwritten label: *Monomorium/cyaneum/* Wheeler/ Lectotype/ M. DuBois 1983/.

Synonymous *M. emersoni* type series consists of "1 queen and 79 workers" (Gregg, 1945): UNITED STATES: *Arizona: Gila Co.;* Globe, April, 1937, A. E. Emerson. Paratype queen and workers: *Texas: Travis Co.;* Austin, A. E. Emerson [paratype queen and 51 workers; NMNH, examined]. Holotype presumably in collection of R. Gregg (Gregg, 1945).

DISTRIBUTION. This species ranges from central Mexico (Mexican Plateau), particularly Hidalgo, Mexico, and Queretaro, east to western Vera Cruz, and west to Nayarit. These localities appear to represent the southern extent of this species. It occurs sporadically northward to southern Texas, New Mexico, and Arizona (Fig. 57). In eastern Texas this species is apparently replaced by *M. minimum* which seems to prefer moister habitats than *M. cyaneum.* The furthest eastern collections are from the San Antonio vicinity. The northernmost extensions of *M. cyaneum* occur in northern Arizona (numerous collections from Grand Canyon vicinity). This species has been collected as far west as the Hualapai Mountains near Kingman, Arizona. Further west, *M. cyaneum* is replaced by *M. ergatogyna,* while further north, *M. wheelerorum* predominates. It is possible that

FIG. 57. Distribution of *Monomorium cyaneum* (closed triangles).

M. cyaneum may someday be discovered in southern Utah and Nevada since the habitat is not significantly different from that of northern Arizona. It appears that while part of the sporadic distribution of this species is due to lack of collections, habitat restriction also plays a part. Most of the localities collected in Arizona and New Mexico represent upland areas (usually canyons within mountain ranges). Thus many populations may be rather isolated. At the southern extents of the range of *M. cyaneum,* most collections are from the Mexican Plateau. Although there are two collections from the state of Vera Cruz, both are from upland areas along the Mexican Plateau. Most collections from the plateau were near Mexico City (from such nearby states as Hidalgo and Queretaro). Collections from the western coast of Mexico are spotty. Only one collection has been made on an island (Maria Cleofas Islas, Nayarit). Three collections have been made in the region of Guaymas, Sonora and one collection in the Baja California peninsula (21 km N of La Paz).

DISCUSSION. BIOLOGY. Wheeler (1914b) indicated this species nests under stones in "rather damp places on the sides of canyons." I have observed this to be the case with colonies of this species I have collected in New Mexico and Arizona. For example, one nest of this species (*ARIZONA: Gila Co.*) was located in such a habitat on the south facing slope of a small canyon.

This nest was concealed under a stone measuring approximately $0.1m^2$. Most of the nest occupied an area about 10 cm in diameter, about 5 cm from the east side of the stone (a populous colony of *Iridomyrmex pruinosus* (Roger) occupied the western portion under this stone). The portion of the *M. cyaneum* nest which was visible after the stone was removed consisted of a series of small chambers (1 cm in diameter) connected by tunnels (3 mm in diameter and 0.5-2 cm in length). The topmost layer of chambers was broken open when the stone was lifted. Most brood was near the surface, with different life stages clustered in separate chambers. Although this nest could only be excavated to a depth of about 7.5-10 cm due to large buried stones, I believe I collected the majority of individuals.

Colonies of *M. cyaneum* have multiple queens, although it is not known whether they are all functional. However, in nests I excavated, each queen was in a separate chamber and surrounded by eggs and first or second instar larvae.

Dates on which sexual forms are released are unknown, although the Gila County (Arizona) colony contained many callow queens and developing male pupae on June 12, 1979.

Monomorium cyaneum has a moderately wide altitudinal range (from 1387 m through 2286 m elevation in Arizona and from 1341 m through 2743 m {type locality} elevation in Mexico).

SYSTEMATICS. Although Gregg (1945) believed *M. emersoni* to be a separate taxon (subspecies), he failed to compare it with *M. cyaneum.* The most prominent feature used to distinguish *M. emersoni* was the prominent tubercles at the point where basal and declivitous faces of the propodeum meet. Although this seems to be a good character upon superficial examina-

tion, one colony (Santa Fe, New Mexico) contained numerous queens which ranged in morphology from the typical *M. cyaneum* propodeum to one with tubercles nearly developed into teeth. Since all other characters indicated this was a queen of *M. cyaneum, M. emersoni* was synonymized; none of the other characters used by Gregg differed from characters found in *M. cyaneum.*

COMPARISON. Since *Monomorium cyaneum* has wingless queens, the following species which occur in or near its range might be confused with it: *M. compressum, M. ergatogyna,* and *M. wheelerorum. Monomorium cyaneum* queens can easily be distinguished from *M. compressum* since the latter species has a depressed scutum and scutellum, an emarginate postpetiole, and fewer than 30 erect to suberect setae projecting above the dorsal profile of the alitrunk. *Monomorium cyaneum* queens differ from *M. ergatogyna* queens since the latter species has a fringe of erect to suberect setae on the anterior edge of the scape and less facial sculpturing than *M. cyaneum* (Fig. 34). *Monomorium cyaneum* queens are easily distinguished from *M. wheelerorum* queens since the latter species has an antennal fringe similar to that of *M. ergatogyna* queens, a flat to slightly depressed scutum and scutellum, and a notal furrow on the mesonotum.

Since the ranges of many species overlap with *M. cyaneum,* it is best to use the keys to separate workers which are not associated with queens. The following species are most likely to be collected within the range of *M. cyaneum: M. compressum, M. ebeninum, M. ergatogyna, M. marjoriae, M. minimum,* and *M. wheelerorum. Monomorium cyaneum* workers can easily be separated from *M. compressum* and *M. ebeninum* workers since the latter two species have a nonpunctate mesopleuron and more than 10 erect to suberect setae projecting from the dorsum of the alitrunk. *Monomorium cyaneum* workers can be separated from *M. ergatogyna* workers since the latter species has a more rounded propodeum and occurs mainly along the California coast. *Monomorium cyaneum* workers can be separated from workers of *M. marjoriae, M. minimum,* and *M. wheelerorum* since the latter three species have a nonpunctate mesopleuron and the basal face of the propodeum is longer than the declivitous face.

Monomorium ergatogyna Wheeler

Figures 1-5, and 58-80

Monomorium minutum: Brues, 1903: 148 (misidentification); Wheeler, 1910: 386 (misidentification).

Monomorium minimum ergatogyna Wheeler, 1904: 269; Wheeler, 1905a: 88; Wheeler, 1917b: 464, 501; Tulloch, 1930: 202; Mallis, 1941: 71 (in part); Smith, 1943: 300; Smith, 1947: 565; Smith, 1952: 810; Cook, 1953: 160-163 (in part).

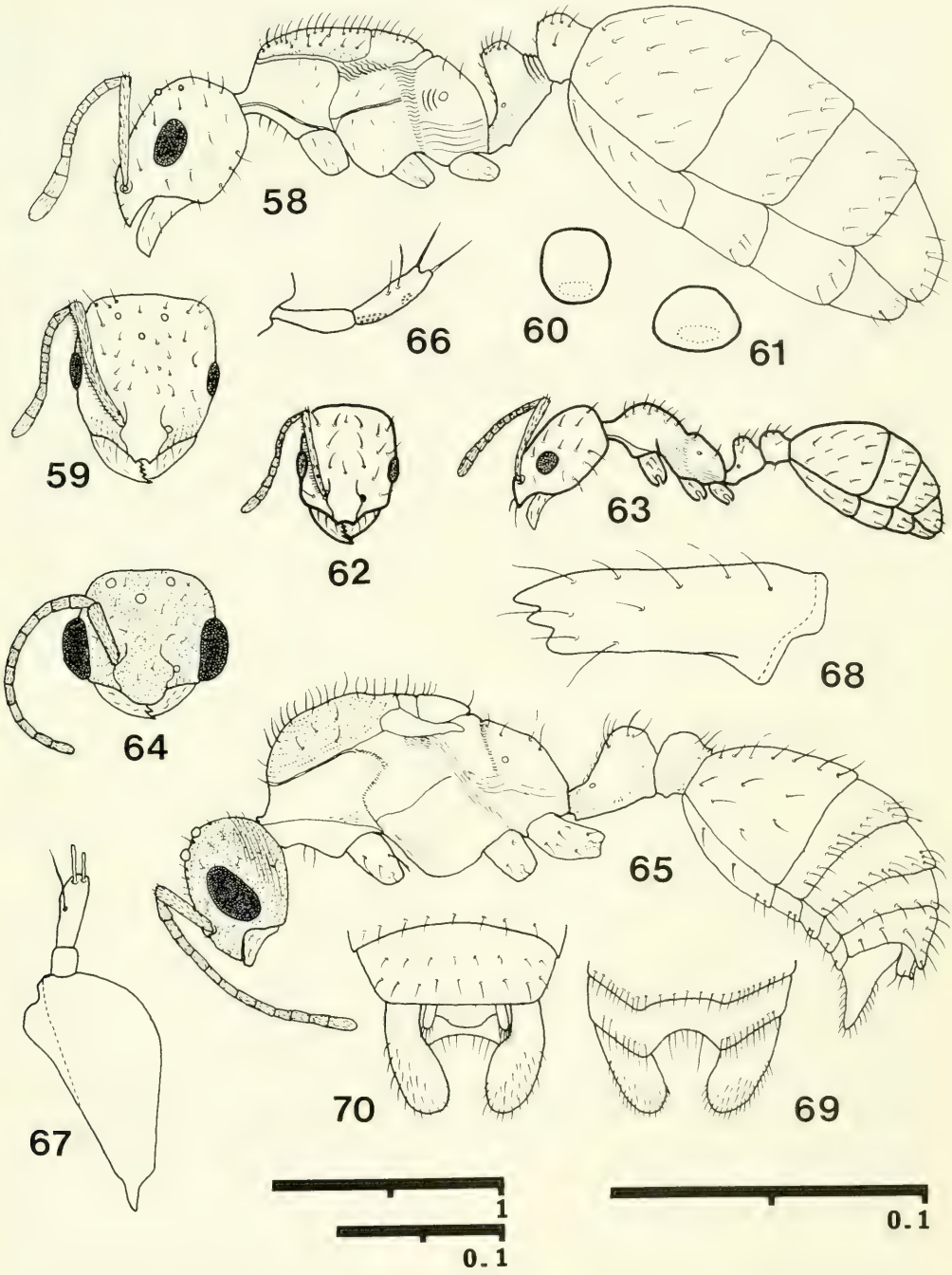
Monomorium minutum subsp. *minima* var. *ergatogyna:* Emery, 1921: 173.

Monomorium minimum: Essig, 1926: 857 (in part); Mallis, 1941: 71 (in part); Creighton, 1950: 219 (in part); Cook, 1953: 160-163 (in part); Smith, 1958: 128 (in part); Ettershank, 1966: 90 (in part); Smith, 1967: 356 (in part); Smith, 1979: 1382-1383 (in part); Snelling and George, (unpubl.).

Monomorium ergatogyna: Essig, 1926: 857.

DIAGNOSIS. QUEEN: Wingless; head (excluding lateral margin of clypeus) lacking nonpiliferous punctures and rugae; alitrunk with more than 30 erect to suberect setae projecting above dorsal outline; petiole and postpetiole as in Figures 58, 60 and 61; antennal pilosity as in Figure 59. MALE: Genitalia and sterna as in Figures 65, 69, 70, and 72-78. WORKER: Propodeum, petiole and postpetiole as in Figure 63; mesopleuron punctate; PI 35-44 (38).

DESCRIPTION. As described for *M. cyaneum* except as indicated. QUEEN: *HEAD: Measurements* (representing different localities; $N = 10$). HL 0.59-0.71 (0.67), HW 0.55-0.65 (0.61), SL 0.41-0.52 (0.47), IOD 0.12-0.18 (0.17), OD 0.04-0.05 (0.05), EL 0.12-0.15 (0.14), MOD 0.09-0.11 (0.10). *Structure*—CI 79-95 (90), SIL 58-77 (70), SIW 63-91 (77). Side straight to slightly convex. Frontal carinae diverging strongly posteriorly. *Pilosity*—Setae erect near clypeus, frons, gula, occiput, and ocelli, suberect to decumbent on malar area, appressed on remainder. Setae of scape erect on anterior edge (forming a fringe of setae, Figure 59), decumbent to appressed on remainder, of pedicel and flagellum (except club) suberect to decumbent, of antennal club appressed. *Sculpture*—Smooth and shining except as follows: moderate, parallel, longitudinal rugae beginning all along lateral margin of clypeus and extending to level of



FIGS. 58-70. *Monomorium ergatogyna.* 58—Queen, lateral view. 59—Head of queen, frontal view. 60—Petiole of queen, posterior view. 61—Postpetiole of queen, posterior view. 62—Head of worker, frontal view. 63—Worker, lateral view. 64—Head of male, frontal view. 65—Male, lateral view. 66—Labial palp of male. 67—Maxilla and maxillary palp of male. 68—Mandible of male. 69—Male genitalia (*in situ*), dorsal view. 70—Male genitalia (*in situ*), ventral view. *Scales:* Top left (1 mm) for Figures 58-65, and 69-70. Lower left (0.1 mm) for Figure 68. Right (0.1 mm) for Figures 66 and 67.

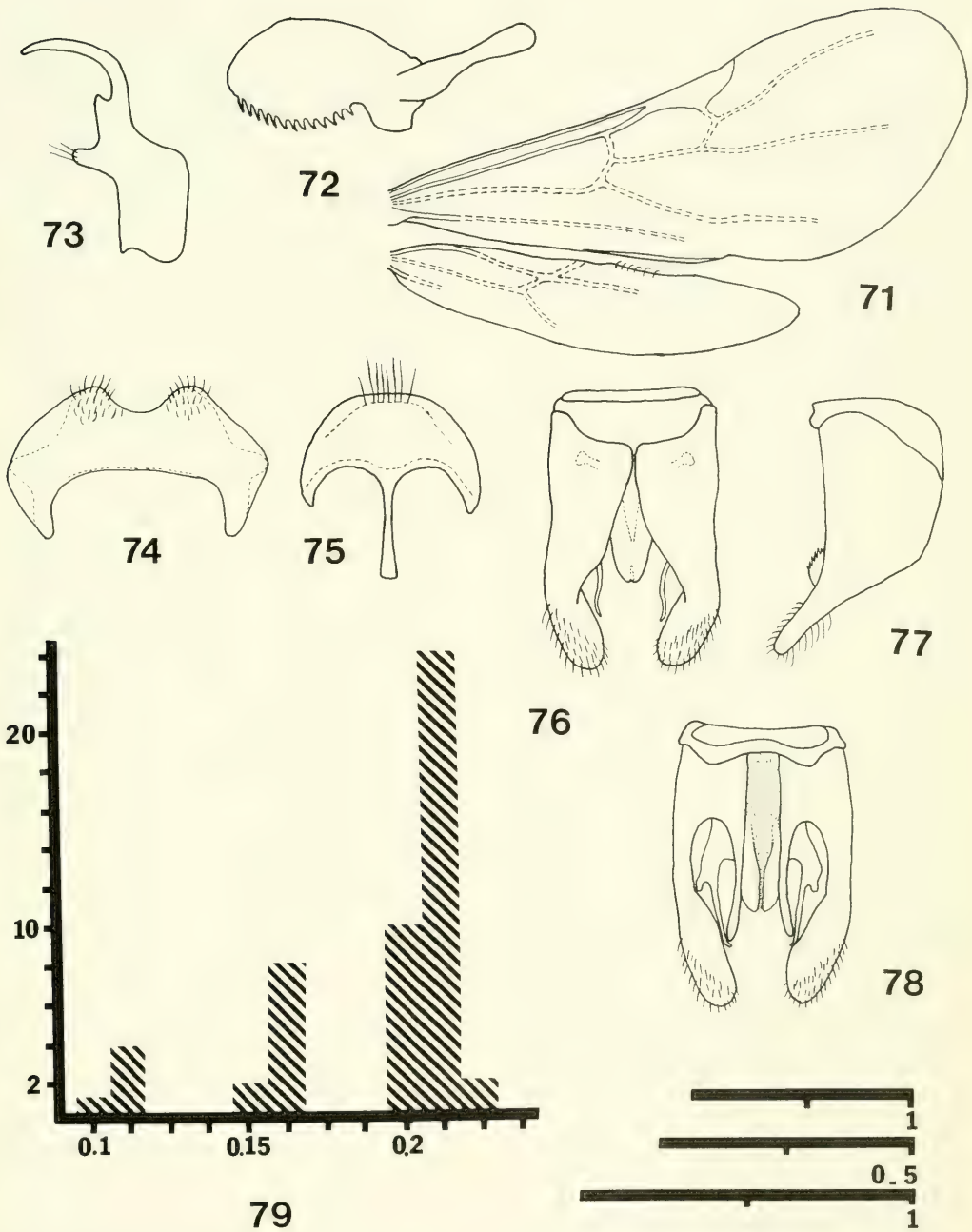
antennal insertion. Small piliferous punctures evenly distributed on head. *ALITRUNK:* Measurements PW 0.40-0.48 (0.43), PL 0.21-0.31 (0.28), WL 1.00-1.15 (1.06). *Structure*—Propodeum evenly rounded (basal and declivitous faces do not meet at an angle). PI 19-28 (26). *Pilosity*—As in *M. minimum*. *Sculpture*—Large piliferous punctures on dorsum of scutum, smaller piliferous punctures on dorsum of scutellum, propodeum and side of alitrunk. Several moderate to large semicircular rugae anterior to propodeal spiracle. *PETIOLE:* As in Figures 58 and 60. Dorsum of node convex. Setae decumbent to appressed on anterior surface of node, erect on dorsum and side of node, and absent from posterior surface of node. Posterior surface of node with large, transverse, concentric, semicircular rugae which extend over half of side of node. *POSTPETIOLE:* As in Figures 58 and 61. Dorsum of node convex. Dorsum and sides of node smooth with piliferous punctures. Posterior 1/5 of node with some non-piliferous punctures.)Sometimes, lower 2/3 of side of node covered with dense, non-piliferous punctures(. *COLOR:* Head brown except as follows: antenna, mandible, and lateral margin of clypeus yellow to yellow brown.

MALE: *HEAD: Measurements* (representing 1 nest; $N = 5$) HL 0.55-0.58 (0.56), HW 0.66-0.71 (0.69), SL 0.29-0.35 (0.31), IOD 0.18-0.20 (0.19), OD 0.06 (0.06), EL 0.24-0.26 (0.25), MOD 0.12-0.16 (0.15). *Structure*—CI 114-127 (123), SIL 53-60 (55), SIW 41-53 (45). *Sculpture*—Large, concentric, transverse rugae occurring on posterior 1/3 of head. Large rugae beginning all along lateral margin of clypeus, continuing behind antennal insertion and converging with frontal carina (Fig. 64).)Occasionally, several moderate rugae may converge on anterior ocellus (Fig. 64)(. *ALITRUNK: Measurements* PW 0.49-0.56 (0.51), PL 0.38-0.42 (0.40), WL 1.28-1.29 (1.29). *Structure*—Pronotal-scutal suture located medially on alitrunk. Propodeum angular (Fig. 65), basal and declivitous faces of approximately equal length. PI 29-33 (31). Wings present (Fig. 71); 5-7 hamuli on hindwing. *Pilosity*—As in *M. minimum*. *Sculpture*—Anterior edge of mesopleuron, near procoxa, with series of small transverse rugae. Sculpturing of sutures as in Figure 65. *PETIOLE:* As in Figure 65. Dorsum of node convex. Setae subdecumbent to appressed on anterior surface of node, suberect to erect on dorsum, absent from posterior surface of node. Side of petiole with small non-piliferous punctures; dorsum smooth and shining with a few piliferous punctures. *POSTPETIOLE:* As in Figure 65. Dorsum of node convex. Anterior subpostpetiolar process of moderate size, located medially on venter. Setae erect to suberect on dorsum and/or posterior surface of node; absent elsewhere. Dorsum of node smooth, remaining surfaces with dense non-piliferous punctures. *GENITALIA:* As in Figures 65, 69, 70, and 72-78. Ninth sternite with 7-10 erect setae (Fig. 75). Aedeagus with 13 teeth (Fig. 72). Cuspis of volsella with 3 setae (Fig. 73).

WORKER: *HEAD: Measurements* (representing separate localities; $N = 10$) HL 0.40-0.60 (0.49), HW 0.33-0.42 (0.39), SL 0.31-0.40 (0.35), EL 0.06-0.10 (0.07), MOD 0.04-0.06 (0.05). *Structure*—CI 70-91 (79), SIL 62-85 (71), SIW 79-98 (89). In full frontal view, side straight. Scape reaching or surpassing occiput by less than length of pedicel. *ALITRUNK: Measurements* PW 0.20-0.28 (0.25), PL 0.18-0.24 (0.20), WL 0.48-0.59 (0.52). *Structure*—Propodeum rounded; declivitous face half length of basal face. PI 35-44 (38). *Pilosity*—Dorsal surface of alitrunk with 18-25 erect to suberect setae. *Sculpture*—Anterior propodeal suture with moderate, longitudinal rugae. *PETIOLE:* As in Figure 63. Dorsum of node convex. *POSTPETIOLE:* As in Figure 63. Anterior subpostpetiolar process of moderate size, located medially on venter. Setae erect on dorsum of node and on venter (beneath node), erect to suberect on sides, remainder bare. Posterior edge of postpetiole with dense, non-piliferous punctures. *COLOR:* Base of mandible, lateral margin of clypeus, and antenna yellow brown.

TYPE MATERIAL. Syntypic series consists of "numerous workers and eight females taken from three different nests" (Wheeler, 1904). *CALIFORNIA: Los Angeles Co.*, Catalina Island, Baker; (16 queens, 21 workers; AMNH), (17 queens, 12 workers; MCZ). Lectotype queen selected from AMNH series bears red, handwritten label: *Monomorium/ ergatogyna/* Wheeler/ Lectotype/ M. DuBois 1980/.

DISTRIBUTION. This species ranges along the Pacific coast of California. It has been collected most frequently in the vicinity of San Francisco and in the vicinity of Los Angeles (including several offshore islands). The range extends inland in the southern portions of California (Fig. 80). The most northern records for this species are Marin Co. (Fairfax, Mill Valley, Mt. Tamalpias, San Anselmo, and Woodacre).



FIGS. 71-79. *Monomorium ergatogyna.* 71—Wings (right side) of male. 72—Aedeagus of male. 73—Volsella of male. 74—Eighth sternite of male. 75—Ninth sternite of male. 76—Male genital capsule, dorsal view. 77—Male genital capsule, lateral view. 78—Male genital capsule, ventral view. 79—Histogram of larval head capsule widths (interval is 0.11 mm). *Scales:* Top scale (1 mm) for Figure 71. Middle scale (0.5 mm) for Figures 72-73. Bottom scale (1 mm) for Figures 74-78.

FIG. 80. Distribution of *Monomorium ergatogyna* (closed circles) and *Monomorium wheelerorum* (closed triangles).

The southern extent of the San Francisco population is represented by collections from Monterey Co. (Fort Ord and Pacific Grove). Records from the Los Angeles vicinity include collections from many of the Channel Islands (Anacapa, East Anacapa, San Clemente, San Miguel, San Nicholas, Santa Barbara, Santa Catalina, Santa Cruz, and Santa Rosa islands). Records in the Los Angeles vicinity range from the San Gabriel Mountains in the north to Camp Pendleton and Mount Palomar in the south. The easternmost record for this species is Palm Springs.

Although future collecting may show the northern and southern populations of this species are connected, there are currently no records from Fort Ord south to the Los Angeles Basin, a distance of approximately 320 Km (Fig. 80). This distribution is similar to that of *M. viridum* on the Atlantic coast which is also represented by two disjunct populations (see further discussion under that species).

DISCUSSION. BIOLOGY. Recorded as nesting under stones (Brues, 1903), in soil or in rotton wood (Essig, 1926). Mallis (1941) records this species (misidentififed as *M. minimum*) nesting in a dry, unshaded area (in the Berkeley Hills) with tumuli forming tiny craters (2-4 cm in diameter).

Further details of nest architecture are unknown. In addition to the variety of nesting sites occupied by *M. ergatogyna,* it has a wide altitudinal tolerance, from 9 m (Long Beach) through 1500 m (H. James Reserve).

Monomorium ergatogyna queens have the longest recorded life span in this genus. Colonies (collected in the field) have been maintained in the laboratory for over two years with the original queens (pers. observ.). This compares with an average queen longevity of 39 weeks for *M. pharaonis* (Peacock and Baxter, 1950) and 8 months to 1 year for *M. minimum* (pers. observ.). *Monomorium ergatogyna* worker longevity varies from 4-8 months (4 months appears to be the usual life span for workers of this genus). There appear to be three larval instars (Fig. 79). Colonies of *M. ergatogyna* have multiple, functioning queens (2-6) (pers. observ.).

Sexual forms emerge during July and August {collections of reproductives: Santa Barbara Island, 12 June 1978 (gyne larvae); Santa Cruz Island, 23 July 1963 (1 male); East Anacapa Island, 23 August 1978 (10 males and 20 unmated queens)}. Only 2 males have been collected from the mainland {Pasadena, 17 April 1929}. If this date is correct, *M. ergatogyna* may produce sexuals twice a year. Another possibility is that an undescribed species occurs sympatrically with *M. ergatogyna;* no morphological differences have been found to support this theory.

Brues (1903) reported a species of *Microdon* (Diptera: Syrphidae) from a nest at Pacific Grove. No other symbionts have been reported.

It appears that the Argentine Ant, *Iridomyrmex humilis* (Mayr), occupies much of the habitat once utilized by *M. ergatogyna* (pers. observ.).

Systematics. A great deal of confusion in previous literature has resulted from the erroneous assumption that *M. minimum* and *M. viridum peninsulatum* occurred in California (see further discussion under *M. viridum*). Furthermore, *M. ergatogyna* was thought to inhabit only the coastal islands (Essig, 1926; Mallis, 1941; Cook, 1953). Although the San Francisco and Los Angeles populations of this species currently appear allopatric, much more collecting must be done before this point can be decided. Additionally, there appear to be some minor size differences between queens from island localities versus those from the mainland. It seems best to regard all this material as *M. ergatogyna.*

Comparisons. Although all known populations of *M. ergatogyna* are geographically removed from any other native *Monomorium,* it is possible that queens of this species might be confused with queens of *M. cyaneum* or *M. wheelerorum. Monomorium ergatogyna* queens can be separated from those of *M. cyaneum* by the fringe of setae on the antennal scape (Figure 61) and the reduced head sculpturing in *M. ergatogyna.* Although *M. ergatogyna* and *M. wheelerorum* are the only species included in this revision which have a fringe of setae on the antennal scape, they can easily be separated, since *M. wheelerorum* has a slightly depressed scutum and scutellum, a mesonotum with a notal furrow, and more extensive sculpturing on the head. Workers of *M. ergatogyna* can be separated by the combination of characters listed in the diagnosis and in the keys, especially: *M. ergatogyna* workers have a rounded propodeum while the prododeum of workers of the other species are more angular. Additionally, workers of *M. wheelerorum* do not have a punctate mesopleuron.

Monomorium wheelerorum new species

Figures 11, 17, 80, and 81-86

Monomorium minimum: Wheeler, 1917a: 464-465, 501 (in part).

DIAGNOSIS. Queen: Wingless; head sculpture as in Figure 82; petiole as in Figures 81 and 83; scutum and scutellum flat or slightly depressed dorsally; metanotum projecting to level of propodeum and scutellum; propodeum angular. Worker: Propodeum angular; mesopleuron not punctate; petiole as in Figure 85; PI 26-40 (34).

DESCRIPTION. As described for *M. cyaneum* except as follows: Queen (data for holotype in brackets {}): *Head: Measurements* (representing different localities; $N = 10$) HL 0.46-0.79

(0.73){0.71}, HW 0.54-0.68 (0.62){0.59}, SL 0.37-0.58 (0.52){0.48}, IOD 0.15-0.21 (0.17) {0.15}, OD 0.04-0.05 (0.04){0.04}, EL 0.14-0.17 (0.15){0.17}, MOD 0.10-0.13 (0.11){0.13}. *Structure*—CI 80-92 (86) {83}, SIL 54-78 (72){68}, SIW 64-95 (84){81}. In full frontal view, side straight. *Pilosity*—As in *M. ergatogyna*. *Sculpture*—Several small, parallel, longitudinal rugae beginning between frontal carinae, extending towards anterior ocellus (but never exceeding 2/3 the distance between posterior end of frontal carina and anterior ocellus). *ALITRUNK: Measurements* PW 0.31-0.46 (0.38){0.46}, PL 0.25-0.34 (0.30){0.25}, WL 1.06-1.29 (1.20){1.08}. *Structure*—Mesonotum with notal furrow. Scutum and scutellum flat to slightly depressed dorsally. Mesopleural suture straight with pit on anterior end. Metanotum (in lateral view) reaching or exceeding level of propodeum and scutellum. Propodeum angular ›rarely rounded‹, basal and declivitous faces of approximately equal length. PI 22-27 (25){22}. *PETIOLE:* As in Figures 81 and 83. Subpetiolar process moderate to enlarged. Setae subdecumbent to decumbent on anterior surface of node, suberect to erect on dorsum, side, and posterior surface of node, absent elsewhere. Posterior surface with small to moderate, semicircular, concentric, transverse rugae. Side with small, parallel, longitudinal rugae extending to and fusing with posterior transverse rugae. *POSTPETIOLE:* As in Figures 81 and 84. Dorsum of node smooth and shining with few small, piliferous punctures, remainder covered with dense, moderate to large, non-piliferous punctures. *COLOR:* Head brown to dark brown, mandible and lateral margin of clypeus yellow brown. Alitrunk dark brown to brown, legs brown to yellow brown, tibiae and tarsi yellow brown to yellow. Petiole, postpetiole, and gaster dark brown to brown. All setae white ›rarely, some setae on gaster light yellow‹.

MALE: Unknown in *M. wheelerorum*.

WORKER. *HEAD: Measurements* (representing different localities; $N = 10$) HL 0.46-0.54 (0.50), HW 0.35-0.42 (0.39), SL 0.30-0.38 (0.36), EL 0.06-0.09 (0.07), MOD 0.05-0.06 (0.06). *Structure*—CI 71-87 (79), SIL 61-76 (72), SIW 85-95 (91). *ALITRUNK: Measurements* PW 0.21-0.26 (0.24), PL 0.12-0.21 (0.17), WL 0.46-0.56 (0.50). *Structure*—Propodeum angular, basal face 1.5X as long as declivitous face. PI 26-40 (34). *Pilosity*—Dorsal outline of alitrunk with more than 10 erect to suberect setae. Setae absent from side, although leg pilosity as in queen. *Sculpture*—As in *M. minimum*. *PETIOLE:* As in Figure 85. Dorsum of node convex. *POSTPETIOLE:* As in Figure 85. Dorsum of node convex.

TYPE MATERIAL. NEVADA: Clark Co.; Wheeler Spring, Spring Mountains, 2012 m, G. C. & J. Wheeler 1561. Holotype queen [LACM] bears red, handwritten label: *Monomorium/ wheelerorum/* Holotype/ M. DuBois 1983/. Two paratype workers [LACM, MBDPC] from same locality bear blue, handwritten label: *Monomorium/ wheelerorum/* Paratype/ M. DuBois 1983/. Additional paratypes distributed as follows (all bearing paratype labels similar to one described above). Localities refer to those listed in detail below which are surrounded by brackets []. Davis Creek Park - 1 queen, 2 workers [MBDPC], Mullen Gap - 1 queen, 2 workers [KU], Sand Canyon - 1 queen, 2 workers [MCZ], Ophir Grade - 1 queen, 2 workers [NMNH].

ETYMOLOGY. This species is named in honor of Drs. George and Jeanette Wheeler who provided many specimens of it.

DISTRIBUTION. This species is known from scattered localities in California, Nevada, and Utah. The majority of collections have come from the vicinity of Lake Tahoe (Fig. 80). *CALIFORNIA: Tulare Co.,* Kennedy Meadows, 1859 m, R. J. Hamton & B. S. Ikeda (under rock). *NEVADA: Clark Co.,* 4.8 km ENE Charleston Peak, 2134 m, G. C. & J. Wheeler 839; *Douglas Co.,* 6.4 km WSW Wellington, 1676 m, G. C. & J. Wheeler 1093; [*Lyon Co.,* Sand Canyon, 1981 m, R. Bechtel]; 12.9 km NW Smith, 1432 m, G. C. &. J. Wheeler 1945; [*Storey Co.,* Ophir Grade, 3.2 km WSW Virginia City, 1981 m, G. C. &. J. Wheeler 2280]; 32 km E. Reno, T19S R20E s 8, 1463 m G. C. & J. Wheeler 2767; [*Washoe Co.,* Davis Creek Park, 1554 m, G. C. & J. Wheeler 2366]; [Mullen Gap, W of S end of Pyramid Lake, I. LaRivers 1484]; 27.4 km N Sparks, 1341 m, G. C. & J. Wheeler 2751. *UTAH: Cache Co.,* Green Canyon, G. Knowlton; Logan Canyon, G. Knowlton; *Kane Co.,* 32 km N Kanab, A. C. Cole; *Salt Lake Co.,* Mill Creek, Chamberlin; Salt Lake City, P. Miles; *Utah Co.,* Provo, Brigham Young

University Campus, M. Tanner; Springville, G. Knowlton; *Washington Co.*, La Verkin, A. Sturtevant.

DISCUSSION. Although the known range of *M. wheelerorum* is allopatric from any other species included in this revision, future collecting may reveal some overlap between this species and *M. cyaneum* and possibly *M. ergatogyna*. Although both queens of *M. wheelerorum* and *M. ergatogyna* have a similar fringe of erect to suberect setae on the scape, *M. wheelerorum* can easily be separated since it also has a flat to slightly depressed scutum and scutellum and a notal furrow on the mesonotum. *Monomorium wheelerorum* queens differ from those of *M. cyaneum* in that queens of the former have the fringe of setae on their scape as described above. Additionally, queens of *M. cyaneum* never have a flat to slightly depressed scutum and scutellum nor a notal furrow on the mesonotum. Workers of *M. wheelerorum* may be separated from workers of *M. ergatogyna* since the latter have a rounded propodeum. Workers of *M. wheelerorum* may be distinguished from workers of *M. cyaneum* since the former possess a propodeum with basal and declivitous faces of equal length while the latter possess a propodeum with the basal face longer than the declivitous face.

Monomorium compressum Wheeler

Figures 87-93

Monomorium minimum subsp. *compressum* Wheeler, 1914b: 43; 1917a: 464, 501; Kempf, 1972: 144.

Monomorium minutum subsp. *minima* var. *compressum:* Emery, 1921: 173.

Monomorium compressum: Ettershank, 1966: 88.

DIAGNOSIS. QUEEN: Wingless; scutum and scutellum depressed dorsally; metanotum (in lateral view) projecting to level of propodeum and scutellum; propodeum angular; petiole as in Figures 87 and 89. WORKER: Propodeum angular; mesopleuron not punctate; petiole as in Figure 91; PI 36-39 (38).

DESCRIPTION. As described for *M. cyaneum* except as follows. QUEEN: *HEAD: Measurements* (representing type locality - probably from same nest; $N=3$) HL 0.60-0.68 (0.64), HW 0.55-0.60 (0.58), SL 0.45-0.50 (0.48), IOD 0.12-0.14 (0.13), OD 0.02-0.04 (0.03), EL 0.11-0.14 (0.12), MOD 0.10 (0.10). *Structure*—CI 80-96 (90), SIL 73-75 (74), SIW 77-91 (83). Eye small. *Pilosity*—Setae erect near clypeus, frontal carinae, mandibles and ocelli, decumbent to appressed on malar area, appressed on remainder of head (including gular region). *Sculpture*—Small parallel rugosities extending from distal portion of clypeus (between clypeal teeth) to level of antennal insertions between frontal carinae (Fig. 88). *ALITRUNK: Measurements* PW 0.38-0.40 (0.39), PL 0.25-0.28 (0.26), WL 0.88-0.90 (0.89). *Structure*—Scutum and scutellum depressed. Mesopleural suture deflected ventrally at posterior end (with a small pit on anterior end). Propodeum angular (Fig. 87), basal and declivitous faces of approximately equal length. PI 27-32 (29). *Pilosity*—Dorsal outline of alitrunk with 8-16 erect to suberect setae (projecting over 3/4 their lengths above outline). *PETIOLE:* As in Figures 87 and 89. Dorsum of node convex to flat. Anterior surface and side of node with small non-piliferous punctures; dorsum smooth with few piliferous punctures; posterior surface with moderate, transverse, concentric, semicircular rugae. *POSTPETIOLE:* As in Figures 87 and 90. Dorsum of node convex to slightly emarginate. Dorsum of node smooth (with few piliferous punctures), remaining surfaces with dense non-piliferous punctures. *GASTER:* As in *M. minimum*. *COLOR:* Head and antenna brown except as follows: base of mandible and lateral margin of clypeus yellow to yellow brown.

MALE: Unknown in *M. compressum*.

WORKER. *HEAD: Measurements* (representing different localities; $N=9$) HL 0.46-0.55 (0.49), HW 0.37-0.44 (0.39), SL 0.27-0.40 (0.33), EL 0.08 (0.08), MOD 0.05-0.06 (0.06). *Structure*—CI 76-87 (80), SIL 54-78 (68), SIW 71-92 (85). Scape reaching but never surpassing occiput. *ALITRUNK: Measurements* PW 0.22-0.28 (0.25), PL 0.17-0.24 (0.20), WL 0.44-0.62 (0.54). *Structure*—PI 36-39 (38). *Pilosity*—Dorsal outline of alitrunk with 8-14 erect to suberect setae. *PETIOLE:* As in Figure 91. Dorsum of node convex. Setae erect on dorsum of node, remainder bare. Lower 1/3 of side with small, non-piliferous punctures (leading to a granular appearance); remainder smooth and shining (dorsum of node with piliferous punctures). *POSTPETIOLE:* As in Figure 91. Posterior 1/3 of postpetiole with dense, non-piliferous punctures; remaining surfaces smooth and shining (dorsum of node with piliferous punctures). *GASTER:* As in *M. minimum*. *COLOR:* Head brown except as follows: base of mandible and antenna yellow brown.

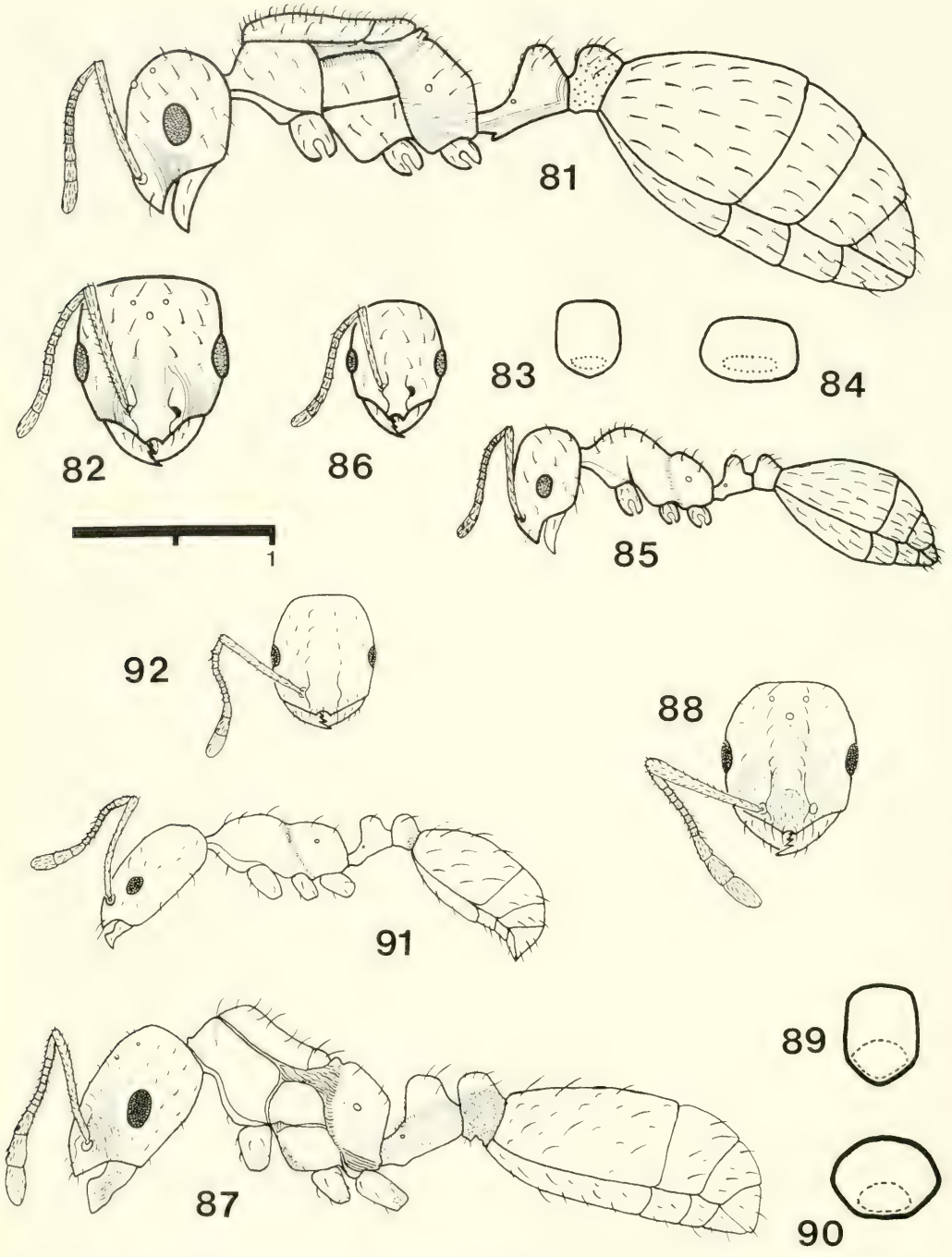


FIG. 81-86. *Monomorium wheelerorum.* 81—Queen, lateral view. 82—Head of queen, frontal view. 83—Petiole of queen, posterior view. 84—Postpetiole of queen, posterior view. 85—Worker, lateral view. 86—Head of worker, frontal view. FIG. 87-92. *Monomorium compressum.* 87—Queen, lateral view. 88—Head of queen, frontal view. 89—Petiole of queen, posterior view. 90 —Postpetiole of queen, posterior view. 91—Worker, lateral view. 92—Head of worker, frontal view. *Scale:* (1 mm) for Figures 81-92.

TYPE MATERIAL. Syntypic series consisting of "4 females and several workers" (Wheeler, 1914b): MEXICO: *Hidalgo:* San Miguel [spring or summer, 1913], W. M. Mann (3 queens, 12 workers; NMNH). Lectotype queen here designated from NMNH series bears red, handwritten label: *Monomorium/ minimum/ compressum/* Wheeler/ Lectotype Queen/ M. DuBois 1983/. The lectotype is mounted on same point with 2 workers which could not be removed.

DISTRIBUTION. This species is known from scattered localities across the Mexican Plateau and extending west to the Pacific coast (Morelos and Hidalgo to Sinaloa) (Figure 93). Collection data for this species follow: MICHOACAN: San José Purula, R. & A. Hamton, B. Ikeda; *MORELOS:* Cuernavaca, N. Krauss; *NAYARIT:* San Blas, R. Hamton; San Blas Playa, E. Schlinger; Tepic; *SINALOA:* Los Mochis; Proterillo 10.5 km E. One collection [*TEXAS:* Marathon, Garden Springs (2 queens, 8 workers; LACM] may be mislabelled, or this species has a much wider range than is indicated above.

DISCUSSION. BIOLOGY. This species

FIG. 93. Distribution of *Monomorium compressum* (closed triangles).

nests under stones (Wheeler, 1914b) but nest architecture is unknown. Colonies of *M. compressum* may have multiple, functioning queens (Wheeler, 1914b).

COMPARISONS. Queens of *M. compressum* can be distinguished from queens of the other species that occurs in its range (*M. cyaneum*), since the former have a depressed scutum and scutellum, an emarginate postpetiole, and fewer than 30 erect to suberect setae projecting above dorsal outline of alitrunk. Workers of *M. compressum* are separated from those of *M. cyaneum* since the former have a smooth mesopleuron and more than 10 erect to suberect setae projecting above dorsal outline of alitrunk.

Monomorium viridum Brown

Figures 9, 15, 21, and 94-100

Monomorium minutum var. *minimum:* Emery, 1895: 274-275 (in part); Wheeler, 1905b: 377 (misidentification).

Monomorium minutum subsp. *minima:* Emery, 1921: 172 (in part).

Monomorium minimum: Smith, 1930: 3; Wheeler, 1932: 9; Van Pelt, Jr., 1948: 58-59, 64; Van Pelt, Jr., 1956: 377, 384; Van Pelt, Jr., 1958: 26 (mididentifications).

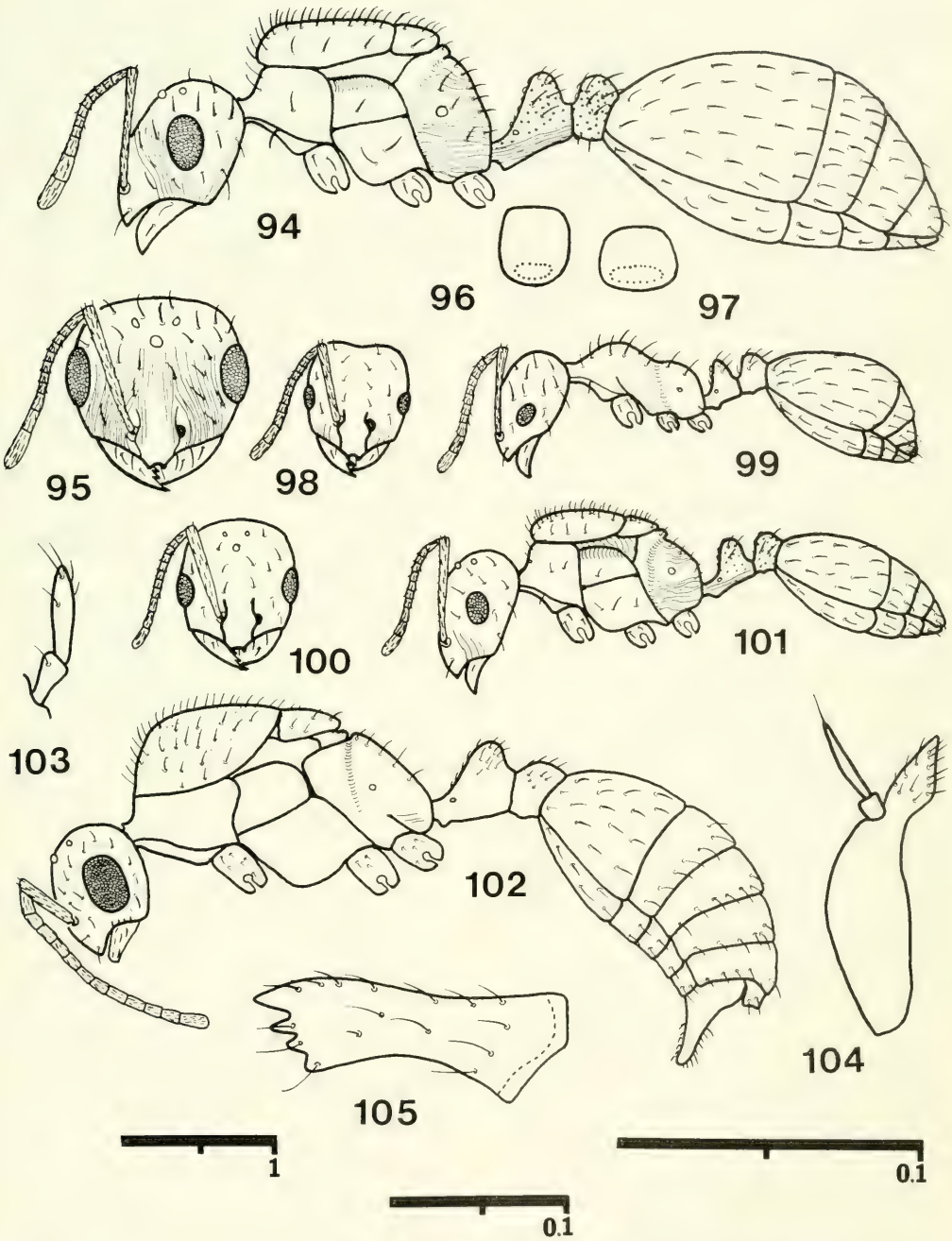
Monomorium viridum Brown, 1943: 243-248; Smith, 1947: 565; Creighton, 1950: 223; Smith, 1952: 811; Ettershank, 1966: 93; Smith, 1967: 356; Crozier, 1970: 116-117; Crozier, 1975: 50, 55; Smith, 1979: 1384; Jones et al., 1980: 789, 791; Jones et al., 1982: 287.

Monomorium peninsulatum Gregg, 1945: 62-66; Smith, 1952: 811; Ettershank, 1966: 91 (NEW SYNONYMY).

Monomorium viridum peninsulatum: Creighton, 1950: 223-224; Smith, 1958: 128; Smith, 1967: 356; Smith, 1979: 1384.

DIAGNOSIS. QUEEN: Winged; head with rugae as in Figure 95; altitrunk with greater than 30 erect to suberect setae projecting above dorsal outline; petiole and postpetiole as in Figures 94, 96, and 97. MALE: Mandible with four teeth (Fig. 105); genitalia and sterna as in Figures 102 and 107-110. WORKER: Propodeum, petiole, and postpetiole as in Figure 99; mesopleuron punctate; PI 31-36 (34).

DESCRIPTION. As described for *M. minimum* except as follows: QUEEN: *HEAD: Measurements:* (representing different localities, $N=8$) HL 0.72-0.88 (0.81), HW 0.80-0.95 (0.88), SL 0.58-0.69 (0.63), IOD 0.16-0.22 (0.19), OD 0.10-0.12 (0.11), EL 0.18-0.28 (0.23), MOD 0.14-0.22 (0.18). *Structure*—Head a little broader than long, CI 102-113 (107), distinctly longer than scape SIL 73-83 (77); SIW 67-76 (72). Scape reaching or surpassing occiput by an amount less than length of pedicel. *Sculpture*—Moderate, parallel, longitudinal rugae beginning all along lateral margin of Clypeus, extending behind antennal insertion, and curving towards frontal carina, reaching frontal carina near apex; small, parallel, longitudinal rugae beginning along malar area, extending towards compound eye, paralleling ocular suture and vanishing near level of anterior ocellus; small, parallel, longitudinal rugae beginning near apex of frontal carina and extending to level of anterior ocellus; moderate, parallel, longitudinal rugae beginning near labium and continuing alson gular region ending near occiput. Large piliferous punctures evenly distributed over entire surface of head. *ALITRUNK: Measurements* PW 0.60-0.85 (0.72), PL 0.30-0.50 (0.38), WL 1.55-1.90 (1.70). *Structure*—Mesonotum with notal furrow. Mesopleural suture straight (small pits on anterior and posterior ends). Propodeum rounded (Basal and declivitous faces of equal length). PI 18-27 (22). *Sculpture*—Moderate, piliferous punctures on dorsum of scutum, scutellum and mesopleural suture. Propodeum covered with moderate, parallel, longitudinal rugae throughout. Sculpturing of sutures as in Figure 94. *PETIOLE:* As in Figures 94 and 96. Dorsum of node flat to slightly emarginate. Setae appressed on anterior surface of node, erect to decumbent on sides, dorsum, and posterior surface of node. Entire surface of petiole covered with small, non-piliferous punctures (obscuring small piliferous punctures where they occur). Lower half of side of petiole)sometimes including lower parts of node(with small, parallel, longitudinal rugae. Posterior surface of node with moderate, transverse, concentric, semicircular rugae. *POSTPETIOLE:* As in Figures 94 and 97. Dorsum of node flat to slightly emarginate. Setae decumbent to appressed on anterior surface of node, suberect to erect on sides, dorsum, and posterior surface of node. Entire surface covered with large to small non-piliferous punctures. *COLOR:* Head dark greenish-brown)green is more pronounced in living or freshly preserved specimens(except as follows: mandibles and antenna dark reddish-brown. Altitrunk and legs reddish-brown with green overlay)green tends to fade in older specimens(. Petiole and postpetiole reddish-brown to brown with slight



FIGS. 94-105. *Monomorium viridum.* 94—Queen, lateral view. 95—Head of queen, frontal view. 96—Petiole of queen, posterior view. 97—Postpetiole of queen, posterior view. 98 —Head of worker, frontal view. 99—Worker, lateral view. 100—Head of ergatogyne, frontal view. 101—Ergatogyne, lateral view. 102—Male, lateral view. 103—Labial palp of male. 104—Maxilla and maxillary palp of male. 105—Mandible of male. *Scales:* Left scale (1 mm) for Figures 94-102. Middle scale (0.1 mm) for Figure 105. Right scale (0.1 mm) for Figures 103 and 104.

green tint. Gaster black with green or blue hues in some specimens.

MALE: *HEAD: Measurements* (representing 2 localities, $N=5$) HL 0.56-0.69 (0.62), HW 0.90-0.95 (0.93), SL 0.28-0.35 (0.31), IOD 0.21-0.26 (0.24), OD 0.14-0.15 (0.15), EL 0.40-0.44 (0.42), MOD 0.25-0.31 (0.28). *Structure*—CI 138-164 (151), SIL 44-55 (50), SIW 30-37 (33). Mandible with 4 teeth (Fig. 105). *Pilosity*—Setae erect to decumbent over entire head, appressed on gula. *Sculpture*—Entire head covered with dense, moderate, non-piliferous punctures. Moderate, parallel, rugae beginning along lateral margin of clypeus and converging at antennal insertion; several moderate, parallel, rugae beginning at malar area, continuing to level of compound eye then paralleling ocular suture; clypeus with small to moderate, parallel, longitudinal rugae arising between clypeal teeth and extending to level of antennal insertion; moderate, parallel rugae extending from frontal carinae to level of anterior ocellus. *ALITRUNK: Measurements* PW 0.84-0.97 (0.93), PL 0.44-0.52 (0.48), WL 1.68-1.84 (1.76). *Structure*—Mesonotum with notal furrow. Scuto-scutellar suture near middle of alitrunk. Mesopleural suture straight. Metanotum not projecting to level of scutellum and propodeum. Propodeum rounded (basal and declivitous faces of equal length, Figure 102). PI 24-29 (28). *Sculpture*—Moderate piliferous punctures on scutum and scutellum and anterior edge of mesopleuron, small, non-piliferous punctures on propodeum. Sculpturing of sutures as in Figure 102. *PETIOLE:* As in Figure 102. Dorsum of node emarginate. Subpetiolar process of moderate size with anterior edge forming angle. Setae appressed to decumbent on anterior surface of node, subdecumbent to erect on dorsum, sides, and posterior surface of node. All surfaces except dorsum, with small, non-piliferous punctures. Lower 1/3 of side of petiole, below node, gitudinal rugae. *POSTPETIOLE:* As in Figure 102. Dorsum of node slightly emarginate. Setae decumbent to erect on all surfaces of node. Dorsum smooth and shining, remaining surfaces covered with small non-piliferous punctures. All surfaces with small piliferous punctures. *GENITALIA:* As in Figures 102, and 107-110. Eighth sternite with emargination possessing setae; emargination approximately half as deep as wide (Fig. 107). Ninth sternite with 18-20 erect setae (Fig. 108). Aedeagus with 12 teeth; toothed margin straight (Fig. 109). Cuspis of volsella with 7 setae (Fig. 110). *COLOR:* As in queen. Genitalia yellow brown to brown.

WORKER. *HEAD: Measurements* (representing different localities; $N=10$) HL 0.45-0.58 (0.51), HW 0.39-0.50 (0.44), SL 0.30-0.40 (0.35), EL 0.08-0.13 (0.09), MOD 0.06-0.08 (0.06). *Structure*—CI 83-89 (85), SIL 53-78 (69), SIW 65-90 (81). Summit of head concave to slightly emarginate. Scape reaching or surpassing occiput by an amount less than length of pedicel. *Sculpture*—Small to moderate, parallel, longitudinal rugae beginning along lateral margin of clypeus, extending to level of antennal insertion. *ALITRUNK: Measurements* PW 0.24-0.33 (0.27), PL 0.18-0.22 (0.20), WL 0.52-0.66 (0.58). *Structure*—Anterior propodeal suture deep (almost reaching to level of propodeal suture). Propodeum rounded; declivitous face 1/3 to 1/2 length of basal face. PI 32-36 (34). *Pilosity*—Dorsal outline of alitrunk with 8-12 erect to suberect setae. *Sculpture*—Mesopleuron with dense, small, non-piliferous punctures throughout; anterior propodeal suture with short, large, parallel, longitudinal rugae. *PETIOLE:* As in Figure 99. Subpetiolar process of moderate size. Setae appressed on anterior surface of node, erect on dorsum of nodes, absent elsewhere. *POSTPETIOLE:* As in Figure 99. Setae apparessed on anterior surface of node, erect to decumbent on sides, dorsum, and venter (beneath node), absent elsewhere. *COLOR:* Head dark brown to brown except as follows: occiput with green tint (most visible in living or recently killed specimens), antenna, mandible, and lateral margin of clypeus brown to yellow-brown. *ALITRUNK:* Dark brown with green tint on dorsum; legs brown to yellow-brown.

ERGATOGYNE. *HEAD: Measurements* (representing different localities; $N=2$) HL 0.66-0.69 (0.68), HW 0.64-0.74 (0.69), SL 0.50 (0.50), IOD 0.14-0.15 (0.14), OD 0.05 (0.05), EL 0.15 (0.15), MOD 0.09-0.10 (0.10). *Structure*—Head as broad as long, CI 97-107 (102), distinctly longer than scape, SIL 72-76 (74); SIW 68-78 (73). In full frontal view, head broadest slightly above eyes; side straight; occiput rounded laterally, summit flat to slightly convex. Eye moderate in size (intermediate between queen and worker). Scape reaching or surpassing occiput by an amount less than length of pedicel. Ocelli present. Mandible, maxillary palp, labial palp, clypeal teeth, and frontal carinae as in queen. *Pilosity*—Setae erect to decumbent over entire surface of head. Antennal pilosity as in queen. *Sculpture*—Smooth and shining except as follows: trace of small, longitudinal, parallel rugae extending from lateral margin of clypeus and converging near frontal carinae. Moderate piliferous punctures evenly distributed over entire

surface (Fig. 100). *ALITRUNK: Measurements* PW 0.48-0.49 (0.48), PL 0.30-0.31 (0.30), WL 1.11-1.26 (0.18). *Structure*—Mesonotum with small pit in place of notal furrow. Scuto-scutellar suture on dorsal 1/3 of alitrunk. Remaining description of alitrunk as in queen except that wings are absent (fusion of sclerites indicate the ergatogynes are wingless). *Pilosity*—As in queen with many erect to suberect setae on sides of propodeum and mesopleuron. *Sculpture*—Smooth and shining with many piliferous punctures throughout thorax. Sculpture of propodeum as in queen (Fig. 101). *PETIOLE:* Dorsum evenly convex to flat. Remaining description as in queen. *POSTPETIOLE:* Dorsum evenly convex to flat. Remaining description as in queen. *GASTER:* As in queen. *COLOR:* As in queen.

TYPE MATERIAL. Type series consisting of holotype female and numerous paratype females, males and workers (Brown, 1943) *NEW JERSEY: Ocean Co.,* Lakehurst, August 23, 1940, W. L. Brown, Jr. [Holotype female - Academy of Natural Sciences, Philadelphia, Pennsylvania Number 10561; paratypes in NMNH and MCZ].

Synonymous *M. peninsulatum* type series consisting of "64 females ... and numerous workers" (Gregg, 1945) *FLORIDA: Dade Co.,* South Miami, E. V. Gregg. [Holotype queen - R. E. Gregg personal collection; paratypes in AMNH, LACM, and NMNH].

DISTRIBUTION. This species occurs in two allopatric populations along the Atlantic coast: one in the Pine Barrens of New Jersey and the other in Georgia and Florida (Fig. 106). In spite of intensive collecting by W. L. Brown, Jr., E. O. Wilson, and others, only one collection has been made in the coastal plain between New Jersey and Georgia (*NORTH CAROLINA: Beaufort Co.,* Wilmar 1.6 km N, W. L. Brown, Jr., & E. O. Wilson). In many areas, this species is replaced by *M. minimum.* Apparently this difference is due to microhabitat selection for nest sites by queens of both species. *Monomorium viridum* prefers sand, while *M. minimum* prefers clay soils (W. L. Brown, Jr. pers. comm.).

In the New Jersey population of *M. viridum,* collections range from Lakehurst (*Ocean Co.*) and Island Heights (*Ocean Co.*) in the north to Cape May (*Cape May Co.*) in the south. Further north, *M. viridum* is replaced by *M. emarginatum* and *M. minimum* replaces both species to the west. In the Florida population, collections are common throughout the eastern and central portions of the peninsula from Jacksonville (*Duval Co.*) in the north to Miami (*Dade Co.*) in the south. The furthest western records for this species appear to be Sarasota (*Sarasota Co.*) and Gainesville (*Alachua Co.*). This population apparently ranges as far north as Georgia (W. L. Brown, Jr., pers. comm.). *Monomorium trageri* occurs in portions of northern Florida (Tallahassee and Gainesville) while *M. minimum* occurs to the north and west of the Florida *M. viridum* population.

DISCUSSION. BIOLOGY. This species nests in open sandy soil. Brown (1943) records it nesting along a roadside with tumuli forming craters 12-20 cm in diameter. Gregg (1945) also mentions the crater nests of this species. Although I have attempted to excavate several nests (*FLORIDA,* Orlando vicinity and Daytona Beach vicinity), I could not determine additional details of nest architecture due to the shifting, loose sand.

Colonies of *M. viridum* may have multiple, functioning queens (1-5) (Brown, 1943). It is not known whether nests are established by one or several queens although Gregg (1945) encountered over 60 queens (most dealate) in one nest. Nuptial flights apparently occur since males and queens are winged, although no flights have been reported and I have not encountered collections of males or queens found away from nests. Sexual forms are produced during July {collection of males: *NEW JERSEY: Burlington Co.,* July 31, 1954; *Ocean Co.,* July 29, 1954}. No males have yet been collected outside of New Jersey.

SYSTEMATICS. Some confusion in the literature has resulted from Gregg's redescription of *M. viridum* as *M. peninsulatum* (Gregg, 1945). Gregg mentions that the species are quite similar and reported characters to separate them (Gregg, 1945: 66). The color characters mentioned are unus-

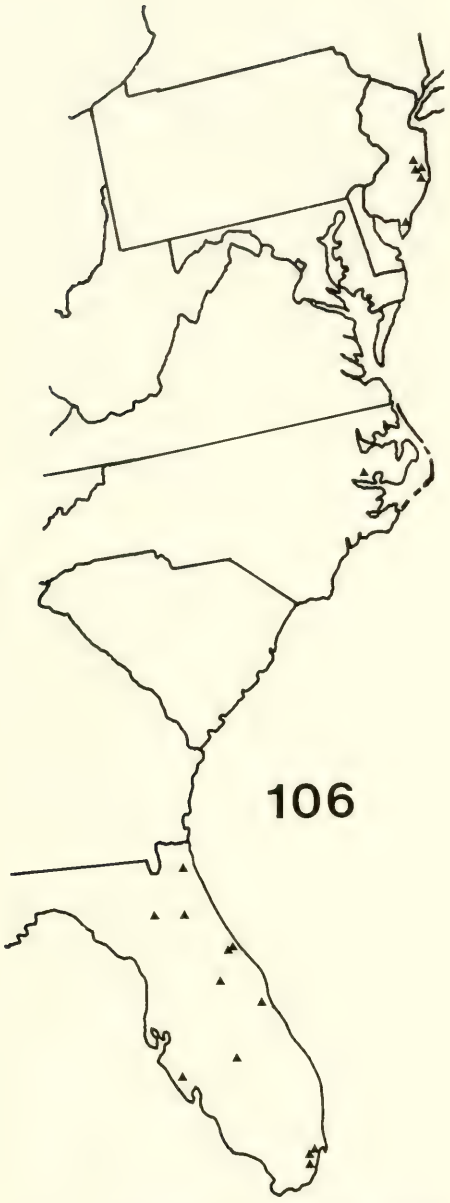


FIG. 106. Distribution of *Monomorium viridum* (closed triangles).

able for a number of reasons. First, Brown stated that his specimens were examined in direct sunlight, while Gregg makes no mention of the light source he used. Second, these colors change and fade over time (the exact sequence is not known). Furthermore, color differences mentioned by Gregg are variable within and among nests. Gregg's characters dealing with the sculpture of the ocellar triangle and the sculpture of the anterior surface of the petiole and postpetiole are equally variable. Size measurements given by Gregg are not useful since they were based upon total length, including gaster (composed of many membranes which shrink as the specimen dries). Length of the gaster can also vary greatly with development of the ovaries (this is true for workers also). This leaves one character, the shape of the clypeal teeth. Gregg described them as blunt but gave no figure for comparison. In fact, they are of the same general shape in specimens from New Jersey and Florida.

This confusion led Creighton (1950) to place *M. peninsulatum* as a subspecies of *M. viridum*. While *M. viridum* continued to be known only from type material, Creighton (using Gregg's variable characters) extended the range of *M. peninsulatum* across the southern United States to Arizona and California, confusing it with *M. minimum, M. cyaneum,* and *M. ergatogyna*. Creighton's error has been perpetuated to the present (Gregg, 1963; Smith, 1979).

COMPARISONS. Ranges of three other species (*M. emarginatum, M. minimum,* and *M. trageri*) overlap the range of *M. viridum*. These species can be separated by characters found in the keys and diagnoses. Queens of *M. viridum* possess a notal furrow on the mesonotum while queens of *M. minimum* and *M. trageri* do not. *Monomorium viridum* queens can be separated from *M. emarginatum* queens since the metanotum of the latter does not project to the level of the propodeum and scutellum. Additionally, head sculpturing is reduced in *M. emarginatum* queens. Furthermore, both petiole and postpetiole are emarginate in *M. viridum* queens.

Workers of *M. viridum* can be separated from *M. trageri* and *M. emarginatum* workers since the latter two species have a propodeum with basal face shorter than declivitous face. *Monomorium viridum* workers can be separated from those of *M. minimum* since the former have a punctate mesopleuron.

Monomorium emarginatum new species

Figures 111-118

Monomorium minimum: Wheeler, 1916: 584 (misidentification).

DIAGNOSIS. QUEEN: Winged; mesonotum with notal furrow; mandible with 4 teeth, basal tooth reduced (Fig. 113); head sculpturing as in Figure 112; petiole and postpetiole as in Figures 111, 114, and 115. WORKER: Propodeum not angular (Fig. 117); mesopleuron not punctate (Fig. 117); petiole and postpetiole as in Figure 117; 4-6 erect setae projecting above dorsal outline of alitrunk; PI 34-42 (37).

DESCRIPTION. As described for *M. viridum* except as follows. QUEEN: *HEAD: Measurements* (representing different localities; $N=6$) HL 0.71-0.80 (0.74){0.80}, HW 0.69-0.81 (0.75){0.81}, SL 0.52-0.64 (0.58){0.62}, IOD 0.16-0.18 (0.17) {0.18}, OD 0.05-0.06 (0.05) {0.05}, EL 0.15-0.19 (0.18) {0.19}, MOD 0.09-0.12 (0.11) {0.12}. *Structure*—Head as broad as long, CI 96-106 (101){101}, distinctly longer than scape, SIL 68-86 (78) {78}; SIW 68-88 (77){76}. Scape not surpassing occiput.{Holotype lacks left antenna}. Mandible with 4 teeth, basal tooth reduced (Fig. 113). *Sculpture*—Moderate, faint, parallel, longitudinal rugae beginning along lateral margin of clypeus, extending past antennal insertion, and converging with frontal carinae. Large to moderate, piliferous punctures evenly distributed (Fig. 112). *ALITRUNK: Measurements* PW 0.58-0.66 (0.62) {0.58}, PL 0.29-0.40 (0.34) {0.40}, WL 1.26-1.65 (1.52) {1.52}. *Structure*—Mesopleural suture straight with small pit on posterior end. Metanotum (in lateral view) not projecting to level of propodeum and scutellum. PI 20-26 (23) {26}. Wings present {lacking on holotype}. *Sculpture*—Smooth and shining with moderate piliferous punctures except as follows: lower 1/3 of propodeum (below spiracle) with moderate to large, parallel, longitudinal rugae. *PETIOLE:* As in Figures 111 and 114. All surfaces smooth and shining (moderate piliferous punctures where applicable) with small non-piliferous punctures (leading to a granular appearance) along lower 1/2 of side. *POSTPETIOLE:* As in Figures 111 and 115. Dorsum of node flat. Setae appressed to decumbent on anterior surface of node, decumbent to suberect on dorsum, erect on posterior surface and side of node, absent elsewhere. Postpetiolar surface smooth and shining with small piliferous punctures throughout. *COLOR:* Head dark brown to brown except as follows: antenna, mandible, and lateral margin of clypeus brown to yellow. Alitrunk dark brown to brown, legs brown to yellow-brown. Petiole, postpetiole, and gaster dark brown to brown. All setae yellow.

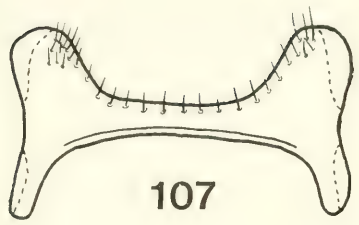
MALE: Unknown in *M. emarginatum.*

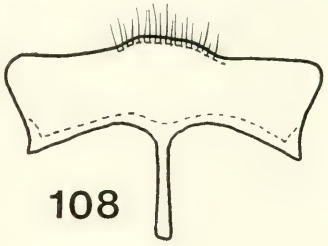
WORKER. *HEAD: Measurements* (representing separate localities; $N=5$) HL 0.44-0.51 (0.48), HW 0.38-0.44 (0.41), SL 0.28-0.41 (0.35), EL 0.09-0.10 (0.09), MOD 0.06 (0.06). *Structure*—CI 80-87 (84), SIL 64-80 (72), SIW 74-93 (86). Scape not surpassing occiput. *Sculpture*—Head smooth and shining with small piliferous punctures evenly distributed. *ALITRUNK: Measurements* PW 0.22-0.29 (0.26), PL 0.18-0.21 (0.19), WL 0.49-0.62 (0.53). *Structure*—Anterior propodeal suture of moderate depth (Fig. 117). Propodeum rounded, basal face 2/3 as long as declivitous face (Fig. 117). PI 34-42 (37). *Pilosity*—Dorsal outline of alitrunk with 4-6 erect setae projecting above dorsal outline. *Sculpture*—Anterior propodeal suture with short, parallel, longitudinal rugae; lower 1/3 of side of propodeum (below spiracle) with small, sometimes faint, parallel, longitudinal rugae. *PETIOLE:* As in Figure 117. Dorsum of node flat to slightly convex. Setae erect on dorsum of node, remainder bare. *COLOR:* Head dark brown except as follows: antenna and madible yellow-brown to brown. Alitrunk brown, legs brown to yellow-brown. Petiole, postpetiole, and gaster brown to dark brown. All setae yellow.

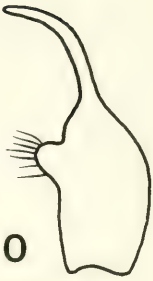
TYPE MATERIAL. VIRGINIA: Rappahannock Co.; Amissville 3.2 km W, June 21, 1957, W. L. Brown, Jr., & E. O. Wilson. Holotype queen [MCZ] bears red, handwritten label: *Monomorium/ emarginatum/* Holotype/ M. DuBois 1983/. Paratypes distributed as follows (localities refer to those listed in detail below which are surrounded by brackets []: Brewster, Cape Cod - 1 queen, 3 workers [MCZ], Woods Hole - 2 queens, 4 workers [NMNH]. All paratypes bear blue, handwritten labels: *Monomorium/ emarginatum/* Paratype/ M. DuBois 1983/.

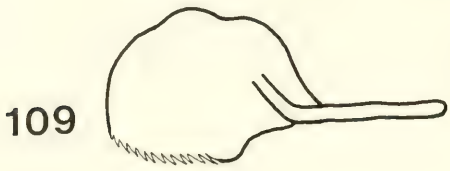
ETYMOLOGY. This species is named for the furrow (emargination) on the mesonotum.

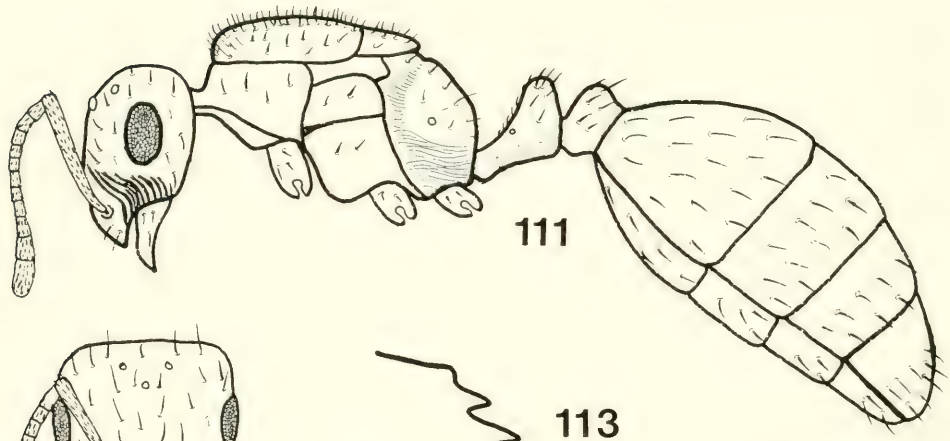
DISTRIBUTION. This species is known from scattered localities throughout the northeastern United States (Fig. 118). Collection data follow: *MASSACHUSETTS:* [*Barnstable Co.,* Cape Cod, Brewster, Au-

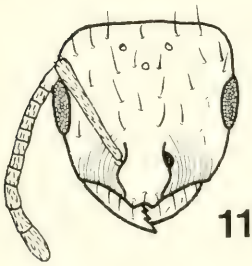


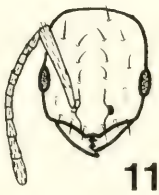


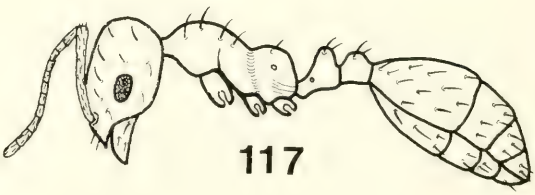












FIGS. 107-110. *Monomorium viridum.* 107—Eighth sternite of male. 108—Ninth sternite of male. 109—Aedeagus of male. 110—Volsella of male. *Scales:* Top scale (0.5 mm) for Figures 107 and 108. Bottom scale (0.5 mm) for Figures 109 and 110. FIG. 111-117. *Monomorium emarginatum.* 111—Queen, lateral view. 112—Head of queen, frontal view. 113—Mandible of queen (schematic). 114—Petiole of queen, posterior view. 115—Postpetiole of queen, posterior view. 116—Head of worker, frontal view. 117—Worker, lateral view. *Scale:* (1 mm) for Figures 111, 112, 114-117.

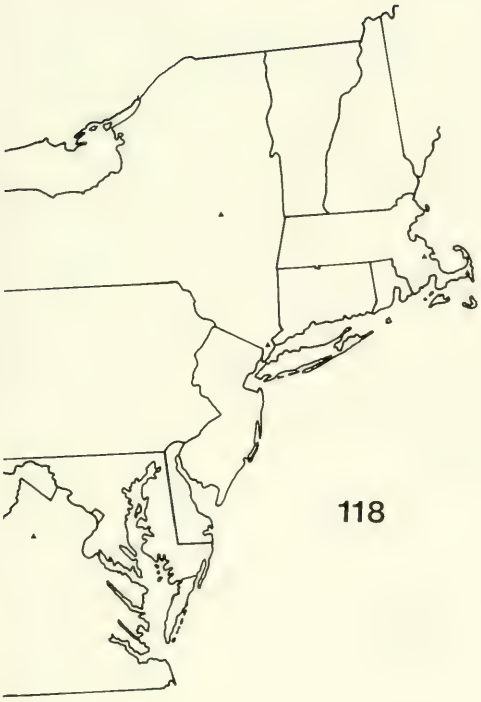


FIG. 118. Distribution of *Monomorium emarginatum* (closed triangles).

gust 4, 1955, W. L. Brown, Jr.]; [*Plymouth Co.,* Woods Hole, July 15, 1930, A. H. Sturtevant]. *NEW YORK:* New York City [several collectors]; *Montgomery Co.,* Johnstown, A. Sturtevant.

DISCUSSION. BIOLOGY. Previous literature records (Wheeler, 1916) indicate that this species prefers to nest in sandy or gravelly soil with tumuli forming tiny craters. Further details of next architecture and biology are unknown.

SYSTEMATICS. Although the collections of this species are sporadic in the northeastern United States, it appears to be the only species which occurs there. Since workers could be easily mistaken for *M. minimum,* I assume this was the species that Wheeler (1916) discussed. Unfortunately, he did not collect any queens during his study and workers are difficult to separate. It is possible this species occurs sympatrically with *M. viridum* in coastal areas.

COMPARISONS. This species is most likely to be confused with *M. minimum* and *M. viridum.* Queens of *M. minimum* can be separated from those of *M. emarginatum* since the latter possess a furrow on the mesonotum. Queens of *M. viridum* can be separated from those of *M. emarginatum* since the petiole and postpetiole of the former are always emarginate while those of the latter are not. Additionally, *M. emarginatum* queens have less facial sculpturing (Fig. 112). Workers of *M. emarginatum* can be separated from both these species since the basal face of the propodeum is shorter than the declivitous face.

Monomorium ebeninum Forel

Figures 8, 14, 16 and 119-133

Monomorium carbonarium: Forel, 1881: 8; Forel, 1899: 78; Kusnezov, 1949: 425 (misidentifications).

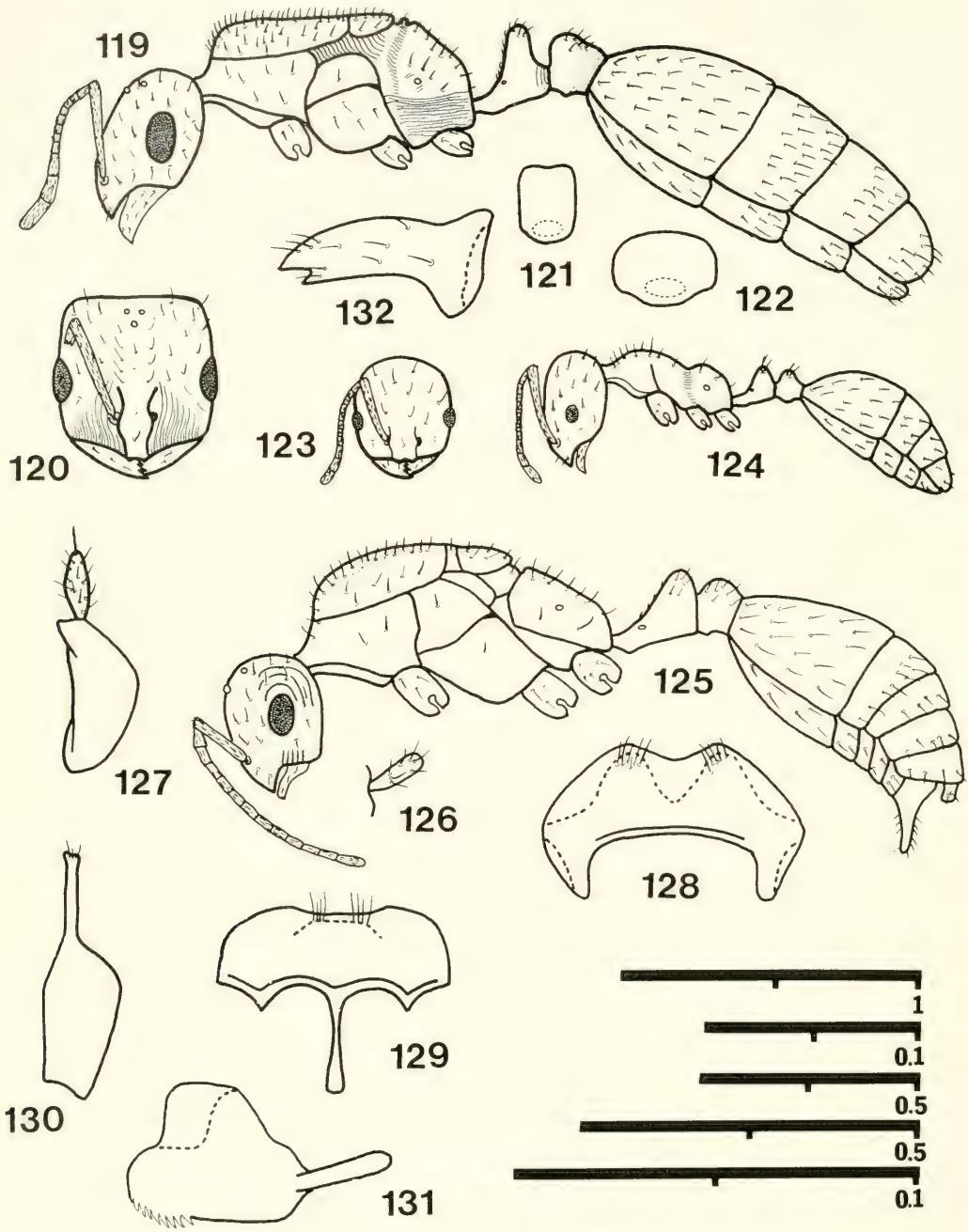
Monomorium ebeninum Forel, 1891: 165; Ettershank, 1966: 88 (misspelled as *ebininum*); Jones et al., 1982: 287.

Monomorium carbonarium ebeninum: Forel, 1899: 78; Wheeler, 1905a: 88-89; Wheeler, 1908: 423; Wheeler, 1917b: 458; Tulloch, 1930: 203; Smith, 1936b: 832-833; Wheeler, 1936: 199; Wolcott & Martorell, 1937: 577-579; Wolcott, 1948: 814-815; Creighton, 1950: 218 (misspelled as *ebininum*); Kempf, 1972: 143; Lavigne, 1977: 224.

Monomorium carbonarium ebenina: Emery, 1921: 171.

DIAGNOSIS. QUEEN: Wingless; petiole and postpetiole as in Figures 119, 121, and 122; scutum and scutellum slightly depressed dorsally or flat; metanotum projecting to level of propodeum and scutellum; propodeum angular. MALE: Genitalia and sterna as in Figures 125, 128-131. WORKER: Propodeum angular; mesopleuron not punctate; petiole as in Figure 121; PI 40-44 (41).

DESCRIPTION. As described for *M. minimum* except as follows. QUEEN: *HEAD: Measurements* (representing different localities; $N = 10$) HL 0.65-0.72 (0.68) {0.72}, HW 0.55-0.65 (0.60) {0.61}, SL 0.42-0.52 (0.49) {0.52}, IOD 0.10-0.17 (0.14) {0.12}, OD 0.04-0.07 (0.05) {0.05}, EL 0.15-0.18 (0.16) {0.18}, MOD 0.10-0.13 (0.12) {0.13}. *Structure*—CI 80-93 (88) {85}, SIL 62-77 (72) {72}, SIW 76-88 (82) {85}. Side of head straight. Scape not reaching occiput. Masticatory margin of mandible with 4 >rarely 5< teeth. Clypeal



FIGS. 119-132. *Monomorium ebeninum.* 119—Queen, lateral view. 120—Head of queen, frontal view. 121—Petiole of queen, posterior view. 122—Postpetiole of queen, posterior view. 123—Head of worker, frontal view. 124—Worker, lateral view. 125—Male, lateral view. 126—Labial palp of male. 127—Maxilla and maxillary palp of male. 128—Eighth sternite of male. 129—Ninth sternite of male. 130—Volsella of male. 131—Aedeagus of male. 132—Mandible of male. *Scales:* Top scale (1 mm) for Figures 119-125. Second scale (0.1 mm) for Figure 132. Third scale (0.5 mm) for Figures 128 and 129. Fourth scale (0.5 mm) for Figures 130 and 131. Bottom scale (0.1mm) for Figures 126 and 127.

teeth moderately sharp to blunt, short. Frontal carinae diverging strongly posteriorly. *Sculpture*—Moderate, parallel, longitudinal rugae beginning all along lateral margin of clypeus, continuing to level of middle of compound eye after converging slightly near frontal carinae ›rugae above frontal carinae may be absent or greatly reduced‹ (Fig. 120). *ALITRUNK: Measurements* PW 0.40-0.52 (0.42) {0.43}, PL 0.23-0.32 (0.29) {0.23}, WL 1.05-1.18 (1.11) {1.13}. *Structure*—Scutum and scutellum slightly depressed dorsally. Mesopleural suture deflected ventrally at posterior end (with small pit on anterior end and larger pit on posterior end). Propodeum angular, basal and declivitous faces of approximately equal length. PI 20-30 (26) {20}. Wings absent (fusion of sclerites indicate queens are wingless). *Sculpture*—Entire propodeum covered with small, non-piliferous punctures (leading to a granular appearance); declivitous surface of propodeum with moderate, parallel, transverse rugae. *PETIOLE:* As in Figures 119 and 121. Dorsum of node flat to slightly emarginate. Setae decumbent to appressed on anterior surface of node, subdecumbent to decumbent on dorsum, absent elsewhere. Entire petiole smooth and shing (with small, piliferous punctures on anterior surface and dorsum) except as follows: posterior 1/5 of petiole with moderate, concentric, semicircular, transverse rugae. *POSTPETIOLE:* As in Figures 119 and 122. Dorsum of node flat. Setae subdecumbent to decumbent on posterior surface of node, absent elsewhere. Postpetiolar surface smooth and shining except as follows: posterior 1/2 with dense, moderate, non-piliferous punctures. *COLOR:* Entire body and appendages usually brown to dark brown. All setae white.

MALE: *HEAD: Measurements* (representing different localities; $N = 3$) HL 0.55-0.61 (0.59), HW 0.61-0.68 (0.64), SL 0.24-0.28 (0.26), IOD 0.18-0.20 (0.19), OD 0.06-0.08 (0.07), EL 0.22-0.25 (0.24), MOD 0.12-0.18 (0.16). *Structure*—CI 100-113 (109), SIL 39-47 (44), SIW 39-41 (40). Maxillary palp 1 - segmented (Fig. 127); labial palp 1 segmented (Fig. 126). Clypeal teeth absent. Frontal carinae not diverging posteriorly. *Pilosity*—Setae erect near clypeus, mandible, and occiput, decumbent to appressed elswhere. *Sculpture*—Several moderate to large, parallel, longitudinal rugae beginning all along lateral margin of clypeus, extending to antennal insertion. Several small to moderate, parallel, longitudinal rugae extending from clypeus to level of frontal carinae. Additionally, several moderate, concentric, semicircular rugae extending from level of compound eye to occiput and following contour of occiput. *ALITRUNK: Measurements* PW 0.50-0.60 (0.56), PL 0.30-0.36 (0.32), WL 1.12-1.27 (1.20). *Structure*—Pronotal-scutal suture on dorsal 1/2 of alitrunk. Mesopleural suture as in queen except as follows: pit absent on anterior end. Metanotum (in lateral view) not projecting to level of propodeum and scutellum. Propodeum angular, basal face 2 times as long as declivitous face. PI 25-28 (27). *Sculpture*—Several moderate, semicircular, concentric rugae with vertex at anterior edge of poronotum, extending posteriorly (as parallel, longitudinal rugae) to scutum; sculpturing of sutures as in Figure 125. *PETIOLE:* As in Figure 125. Setae appressed on anterior surface of node, erect to suberect on dorsum, absent elsewhere. Entire surface of node, erect to suberect on dorsum, absent elsewhere. Entire surface smooth and shining. *POSTETIOLE:* As in Figure 125. Setae decumbent to subdecumbent on anterior surface of node, erect to suberect on posterior surface of node and venter, absent elsewhere. All surfaces smooth and shining. *GASTER:* Setae of first gastral tergite reaching or exceeding level of dorsum of postpetiolar node. *GENITALIA:* As in Figures 125 and 128-131. Eighth sternite with emargination approximately 1/2 as deep as wide (Fig. 128). Ninth sternite with 8 erect setae (Fig. 129). Aedeagus with 8 teeth; toothed margin straight (Fig. 131). Volsella with reduced digitus; lacking cuspis (Fig. 130). *COLOR:* Head and antenna brown to dark brown except as follows: mandible yellow to yellow-brown. Alitrunk brown to dark brown, legs yellow to yellow-brown. Petiole and postpetiole brown to yellow-brown, gaster brown to dark brown. Genitalia brown to yellow-brown. All setae white to yellow.

WORKER. *HEAD: Measurements* (representing different localities; $N = 10$) HL 0.48-0.55 (0.51), HW 0.38-0.42 (0.40), SL 0.35-0.40 (0.39), EL 0.07-0.09 (0.08), MOD 0.05-0.06 (0.05). *Structure*—CI 76-84 (78), SIL 67-95 (78), SIW 71-105 (95). Side of head straight. Clypeal teeth short, blunt. *Sculpture*—Several small, short, parallel, longitudinal rugae on clypeus; several small, short, parallel, longitudinal rugae beginning all along lateral margin of clypeus, continuing to antennal insertion. *ALITRUNK: Measurements* PW 0.25-0.28 (0.26), PL 0.21-0.25 (0.23), WL 0.52-0.62 (0.56). *Structure*—Propodeum angular, both faces of approximately equal length. PI 40-44 (41). *PETIOLE:* As in Figure 124. Dorsum of node flat to slightly emarginate. Setae erect to suberect on dorsum

of node, absent elsewhere. *POSTPETIOLE:* As in Figure 124. Dorsum of node flat to slightly emarginate. *GASTER:* Setae of first gastral tergite reaching or exceeding level of dorsum of postpetiolar node. *COLOR:* Head dark brown to brown except as follows: mandibles yellow-brown to brown. Alitrunk and legs dark brown to brown. Gaster dark brown.

TYPE MATERIAL. Syntypic series consisting of 2 queens, 1 male, and 16 workers (MHNG) from the following localities: GRENADA (male), ST. VINCENT (queens), ST. THOMAS (ANTILLE) (workers). Six workers bear the date 14 X 78. Lectotype queen here designated from MHNG series bears red, handwritten label: *Monomorium/ ebeninum/* Forel/ Lectotype/ M. DuBois 1983/. It is from St. Vincent.

Forel (1891: 165) described the distinguishing characters of this species: "La race de l'Amérique tropicale que j'avais cru devoir rapporter au *carbonarium* (Ameisen der Antille St. Thomas, 1881) et que j'ai recue dés lors du Guatémala, etc., se distingue nettement par les deux élévations du métanotum, par sa large échancrure méso-métanotale, par la face déclive plus haute du métanotum plus éléve qui forme presque un angle avec la face basal, par le premier noeud du pédicule plus mince et plus longuement pétiolé. Je propose de l'appeler *ebeninum.*" Presumably, the material from Guatemala was provided through Pergande (W. L. Brown, Jr., pers. comm.); however, none of this material can be discovered in the remains of Pergande's collection. The remainder of this type series is in Geneva (MHNG). A few of these specimens are clearly labelled "TYPUS"; these include the male, both queens, and 6 workers. I assume that Forel regarded these specimens as part of his type series and merely chose to list their localities as "etc." when he described *M. ebeninum.* I chose the lectotype, designated above, in an effort to restrict the type locality and to reduce future confusion since queens are easier to identify than workers.

DISTRIBUTION. This species ranges throughout the Caribbean region. It has been collected from many of the islands and from Atlantic and Pacific coastlines in many parts of Central America (Fig. 133). Many collections were examined from the following islands which range from the Bahamas in the north through Tobago in the south: Andros (Bahama Islands), Antigua (Lesser Antilles), Barbados (Lesser Antilles), Cuba (Greater Antilles), Dominican Republic (Greater Antilles), Grenada (Lesser Antilles), Haiti (Greater Antilles), Isla de Pinos (Greater Antilles), Jamaica (Greater Antilles), Martinique (Lesser Antilles), Montserrat (Lesser Antilles), Nassau (Bahama Islands), Nevis (Lesser Antilles), Puerto Rico (Greater Antilles), St. Croix (Virgin Islands), St. John (Virgin Islands), St. Vincent (Lesser Antilles), and Tobago (Lesser Antilles). Mainland collection localities range from Tamalupias and Vera Cruz in Mexico to Panama along the Atlantic coast. Only a few collections have been made along the Pacific coast of Central America. These include localities in Oaxaca in Mexico, El Salvador, and Guanacaste Province in Coasta Rica. I was unable to examine any specimens of this species collected in the northern coastal regions of South America or from peninsular Florida. It is probable that additional collecting will reveal colonies from both these regions.

DISCUSSION. BIOLOGY. This species presumably nests under stones and in plant cavities. Forel (1899) indicated that *M. ebeninum* lives in stems and hollow branches. Wheeler (1905a) recorded it from under stones, in cavities of *Tillandsia* spp., and in dry twigs of buttonwood bushes. Smith (1936b: 832) elaborated further: "This is one of the most common ants of the West Indies... It forms populous colonies which are characterized by having many reproductive queens to a colony. Their greath adaptability is indicated by the fact that this species nests in both soil and wood, back of the leaf sheaths or [*sic*] corn and bananas, in cabbage heads, *Tillandsias,* and in the fruits of *Hibiscus sabdariffa.* The workers are exceedingly fond of honeydew. They have been noted attending such insects as *Saissetia hemispherica* Targ., *Coccus viridus* Green, the

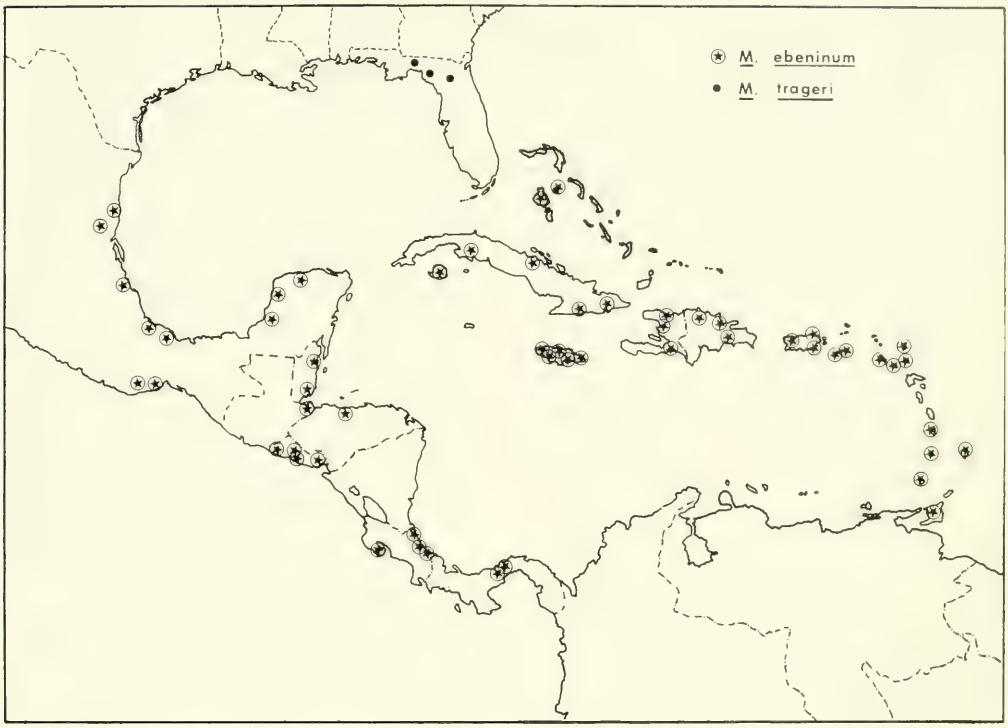
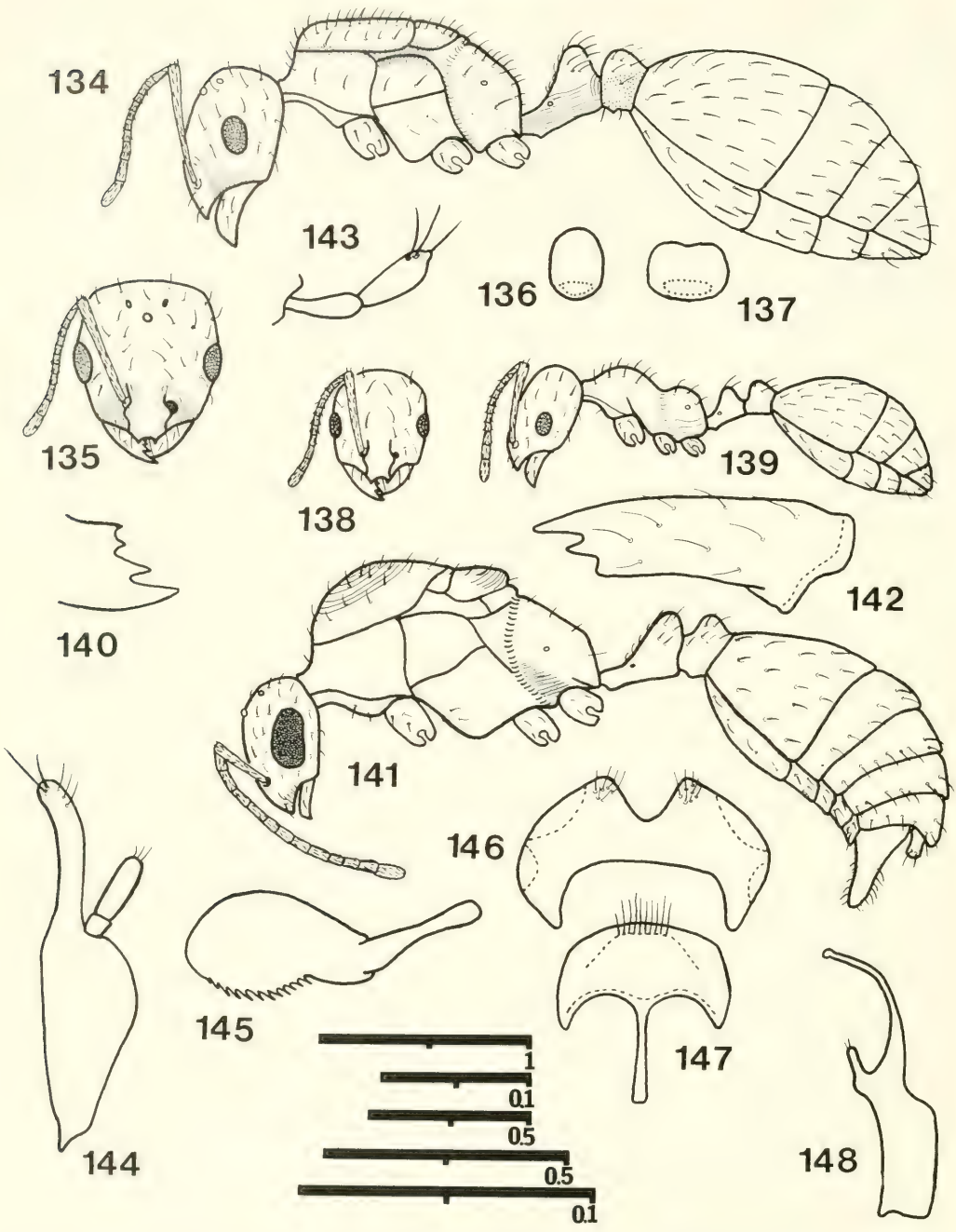


FIG. 133. Distribution of *Monomorium ebeninum* and *Monomorium trageri.*

aphid *Sipha flava* Forbes, etc. The ants are also highly predacious.'' Wolcott and Martorell (1937) recorded this ant as a predator on the eggs of the sugarcane moth borer, *Diatraea saccharalis* Fabricius (Lepidoptera: Pyralidae). Although Lavigne (1977) recorded this species from lawns in Puerto Rico, he provided no details on the nest's microhabitat nor structure. Wheeler (1905a) recorded multiple queens per nest (up to 12). Although *M. ebeninum* has a moderately broad altitudinal tolerance (0-1600 m above sea level), it is most frequently collected in coastal areas (Fig. 133). Sexual forms are produced in spring {collections of males: JAMAICA: Montego Bay, March 14, 1911; ANDROS ISLAND (Bahama Islands): Mangrove Cay, May 31, 1904}.

Wolcott (1948) mentions this ant is eaten by the lizards *Anolis stratulus* and *A. cristatellus.* Lavigne (1977) collected workers from stomachs of the following two frog species: *Eleutherodactylus cochranae* and *E. coqui.*

COMPARISONS. Since *Monomorium ebeninum* is the only species with wingless queens that occurs in the Caribbean region, it should not be confused with any other species. Three other species occur in areas which border the range of *M. ebeninum: M. cyaneum, M. trageri,* and *M. viridum.* Queens of *M. ebeninum* are separated from those of these other species since the profile of the scutum and scutellum of *M. ebeninum* queens is flat or slightly concave while the profile of the remaining species is clearly convex. Additionally, the head sculpturing in *M. ebeninum* is quite reduced. Workers of *M. ebeninum* can be separated from the other species since their propodeum has basal and declivitous faces of approximately equal length. Although this is also true of *M. cyaneum* workers, the mesopleuron in *M. ebeninum* workers is smooth and shining, while it is punctuate in *M. cyaneum* workers.



FIGS. 134-148. *Monomorium trageri.* 134—Queen, lateral view. 135—Head of queen, frontal view. 136—Petiole of queen, posterior view. 137—Postpetiole of queen, posterior view. 138—Head of worker, frontal view. 139—Worker, lateral view. 140—Mandible of queen (schematic). 141—Male, lateral view. 142—Mandible of male. 143—Labial palp of male. 144—Maxilla and maxillary palp of male. 145—Aedeagus of male. 146—Eighth sternite of male. 147—Ninth sternite of male. 148—Volsella of male. *Scales:* Top scale (1 mm) for Figures 134-139, 141. Second scale (0.1 mm) for Figures 140 and 142. Third scale (0.5 mm) for Figures 146 and 147. Fourth scale (0.5 mm) for Figures 145 and 148. Bottom scale (0.1 mm) for Figures 143 and 144.

Monomorium trageri new species

Figures 7, 20, and 133-148

Monomorium new sp. near *minimum:* Jones et al., 1982: 287.

DIAGNOSIS. QUEEN: Wingless)usually(; mandible with 4 teeth, basal 2 reduced (Fig. 140); head smooth and shining except for rugosities near lateral margin of clypeus (Fig. 135); mesonotum lacking notal furrow. MALE: Genitalia and sterna as in Figures 141, and 145-148. WORKER: Propodeum angular (basal face 1/2 as long as declivitous face); mesopleuron punctate; petiole and postpetiole as in Figure 139; 8-12 erect to suberect setae on dorsum of alitrunk; PI 31-38 (35).

DESCRIPTION. As described for *M. ebeninum* except as follows. QUEEN: *HEAD: Measurements* (representing 2 localities; $N=5$) HL 0.62-0.70 (0.66) {0.68}, HW 0.53-0.62 (0.59) {0.53}, SL 0.38-0.55 (0.46) {0.55}, IOD 0.12-0.18 (0.15) {0.12}, OD 0.05 (0.05) {0.05}, EL 0.14-0.16 (0.15) {0.14}, MOD 0.10-0.11 (0.10) {0.10}. *Structure*—CI 80-97 (88) {88}, SIL 59-81 (68) {81}, SIW 63-104 (78) {104}. Eye small to moderate in size. Scape usually not surpassing occiput)or surpassing it by less than length of pedicel(. Mandible with 4 teeth (basal two reduced, Figure 140). Clypeal teeth sharp, short to moderate in length. Frontal carinae diverging slightly posteriorly. *Pilosity*—Setae erect to suberect over entire surface of head except as follows: setae suberect to decumbent on mandible. *Sculpture*—Moderate, parallel, longitudinal rugae beginning all along lateral margin of clypeus, extending past antennal insertion and converging with frontal carina. *ALITRUNK: Measurements* PW 0.42-0.48 (0.44) {0.42}, PL 0.25-0.31 (0.29) {0.30}, WL 1.02-1.20 (1.13) {1.15}. *Structure*—Scutum and scutellum not depressed or flat. Mesopleural suture straight with no pits at either end. PI 24-28 (25) {26}. *Sculpture*—All sutures surrounding scutum and scutellum covered with small, dense, non-piliferous punctures (Fig. 134). Propodeum covered with dense, small, non-piliferous punctures throughout (obscuring any trace of rugae on lower side of propodeum). *PETIOLE:* As in Figures 134 and 136. Setae appressed on anterior surface of node, erect to suberect on dorsum, side, and posterior surface of node, absent elsewhere. Dorsum of node smooth and shining with small piliferous punctures; side covered with moderate to large longitudinal and transverse rugae (Fig. 134). *POSTPETIOLE:* As in Figures 134 and 137. Dorsum of node slightly emarginate. Setae suberect to erect on dorsum, posterior surface, side, and venter of node, absent elsewhere. Dorsal surface of postpetiole smooth and shining with small piliferous punctures; lower 2/3 of side (below node) with small to moderate, dense, non-piliferous punctures. *GASTER:* Setae of first gastral tergite exceeding level of dorsum of postpetiolar node.

MALE: *HEAD: Measurements* (representing 1 locality; $N=5$) HL 0.55-0.60 (0.58), HW 0.70-0.72 (0.71), SL 0.25-0.30 (0.26), IOD 0.18-0.22 (0.19), OD 0.05-0.08 (0.06), EL 0.25-0.28 (0.27), MOD 0.15-0.18 (0.17). *Structure*—CI 117-131 (124), SIL 42-50 (45), SIW 35-42 (36). Maxillary palp 2-segmented (Fig. 144); labial palp 2-segmented (Fig. 143). Frontal carinae diverging slightly posteriorly. *Sculpture*—Moderate to large, parallel, longitudinal rugae beginning all along lateral margin of clypeus, extending to level of middle of compound eye. Moderate, parallel, longitudinal rugae beginning all along distal border of clypeus (between clypeal teeth) and continuing up clypeus and frons to level of antennal insertion. Several moderate, faint, semicircular rugae occurring on occiput and following contours laterally around occiput (these rugae are partially obscured by punctation). *ALITRUNK: Measurements* PW 0.62-0.65 (0.64), PL 0.30-0.38 (0.34), WL 1.30-1.35 (1.33). *Structure*—Mesopleural suture straight with small pit present on both anterior and posterior ends. Metanotum (in lateral view) projecting to level of scutellum and propodeum. Propodeum angular, basal face 2/3 as long as declivitous face. *Pilosity*—Several setae suberect to erect on lower 1/3 of mesopleuron (katepisternum). Propodeum with 2 - 4 erect to suberect setae. *Sculpture*—Smooth and shining with large piliferous punctures on dorsum. Entire propodeum smooth and shining. *PETIOLE:* As in Figure 141. Dorsum of node flat to slightly emarginate. Setae erect to suberect on dorsum, side and posterior surface, absent elsewhere. Entire petiole smooth and shining; lower 1/3 of side with faint, moderate rugae. *POSTPETIOLE:* As in Figure 141. Dorsum of node emarginate. Setae erect to suberect on anterior surface, side, posterior surface, and venter, absent elsewhere (including dorsum of node). Entire surface of postpetiole smooth and shining except for posterior 1/2 of node which is covered with small to moderate, non-piliferous punctures. *GASTER:* Setae of first gastral tergite not exceeding level of dorsum of postpetiolar node. *GENITALIA:* As in Figures 141, and 145-148. Eighth sternite with emargination approximately as deep as wide (Fig. 146). Ninth sternite with 10 erect setae (Fig. 147). Aedeagus with 12 teeth, toothed margin rounded (Fig.

145). Volsella with curved digitus and reduced cuspis; cuspis with 2 setae (Fig. 148). *Color:* Head dark brown except as follows: antenna and clypeus brown. Alitrunk brown, legs yellow brown, wings hyaline. Petiole, postpetiole, and gaster brown to dark brown. Genitalia brown to yellow brown. All setae white.

Worker. *Head: Measurements* (representing 1 locality; $N=5$) HL 0.45-0.52 (0.49), HW 0.35-0.45 (0.42), SL 0.25-0.38 (0.30), EL 0.08-0.10 (0.09), MOD 0.05-0.08 (0.07). *Structure*—CI 75-93 (86), SIL 48-76 (61), SIW 56-84 (72). Side of head convex. Scape reaching occiput but not surpassing it by length greater than length of pedicel. Mandible with 4 teeth ⟩sometimes, basal 2 reduced⟨. Clypeal teeth sharp, of moderate length. *Sculpture*—Smooth and shining with moderate piliferous punctures evenly distributed throughout. *Alitrunk: Measurements* PW 0.25-0.28 (0.27), PL 0.15-0.20 (0.18), WL 0.45-0.53 (0.50). *Structure*—Propodeum angular, basal face 1/2 as long as declivitous face. PI 31-38 (35). *Pilosity*—Dorsal outline of alitrunk with 8-12 erect to suberect setae. Leg pilosity as in queen. *Sculpture*—Mesopleuron covered with dense, small, non-piliferous punctures. Anterior propodeal suture with short, parallel, moderate, longitudinal rugae. *Petiole:* As in Figure 139. Dorsum of node convex. Setae erect on dorsum of node, absent elsewhere. *Postpetiole:* As in Figure 139. Dorsum of node flat. Setae erect on dorsum and posterior surface of node, absent elsewhere. *Gaster:* Setae of first gastral tergite not projecting to level of dorsum of postpetiolar node. *Color:* Head dark brown (with bluish reflections) except as follows: antenna and mandible brown to light brown. Alitrunk brown to dark brown, legs light brown. Petiole, postpetiole, and gaster dark brown with bluish reflections. All setae white.

TYPE MATERIAL. Holotype Queen: *Florida: Alachua Co.*, Gainesville, April 5, 1980, J. C. Trager. Holotype, deposited in NMNH, bears red, handwritten label: *Monomorium/ trageri/* Holotype/ M. DuBois 1983/. Paratypes are deposited as follows: CAS (1 queen, 1 male, 1 worker), AMNH (1 queen, 1 male, 1 worker), JCTPC (1 queen, 1 male, 1 worker), KU (1 queen, 2 males, 3 workers), LACM (1 queen, 1 male, 1 worker), MBDPC (1 queen, 2 males, 3 workers), MCZ (1 queen, 1 male, 1 worker), NMNH (1 queen, 1 male, 1 worker). All paratypes bear blue, handwritten labels: *Monomorium/ trageri/* paratype/ M. DuBois 1983/.

ETYMOLOGY. This species is named in honor of James C. Trager, who provided many specimens of it.

DISTRIBUTION. This species is quite rare; it is known from only four localities in Florida. In addition to the type locality, specimens have been collected in Tallahassee, LaCrosse, and Punta Gorda (Fig. 133). It is possible that earlier records of *M. minimum* from Florida (e.g., Van Pelt, 1958) may have represented collections of this species. However, no specimens from these earlier studies could be located. It is more probable earlier records referred to *M. viridum* which is more common in penisular Florida, but does not range as far west as Tallahassee. Additional collecting in northern Florida and southern Georgia may elucidate the distribution of *M. trageri.*

DISCUSSION. Biology. Although details of nesting preferences are unknown (little can be inferred from 4 collections), the colony which yielded the holotype and paratypes was collected from beneath a board in a cow pasture (J. Trager, pers. comm.). The colony collected in LaCrosse (Alachua Co.) was collected in cow dung.

The type colony was reared in the laboratory from 5 April through 20 June when portions of it were killed. At that time, numerous males and queens were present. One male and queen were preserved *in coitu* indicating that mating may occur between males and closely related queens. Several specimens examined are probably intersexes (female head and male alitrunk and gaster). These may have been caused by some form of mechanical damage to the developing individuals (W. L. Brown, Jr., pers. comm.).

Recently, James Trager provided additional specimens of the Gainesville colony. A few queens are winged, indicating that genes which code for wings are still present within this population; approximately 90% of the queens are wingless and 10% are winged.

Comparisons. *Monomorium trageri* is likely to be confused with the following

species: *M. ebeninum, M. minimum,* and *M. viridum.* Queens of *M. trageri* may be separated from those of *M. ebeninum* since the latter have a flat or concave scutum and scutellum. Queens of *M. trageri* may be separated from those of *M. viridum* since the latter have a furrow on the mesonotum. Queens of *M. trageri* may be separated from those of *M. minimum* since the former have reduced sculpturing on the head; the only rugae are along the lateral margin of the clypeus. *Monomorium minimum* queens have more facial sculpturing. Workers of *M. trageri* may be separated from workers of the other three species since they have the basal face length of the propodeum less than the length of the declivitous face.

Monomorium marjoriae new species

Figures 149-154

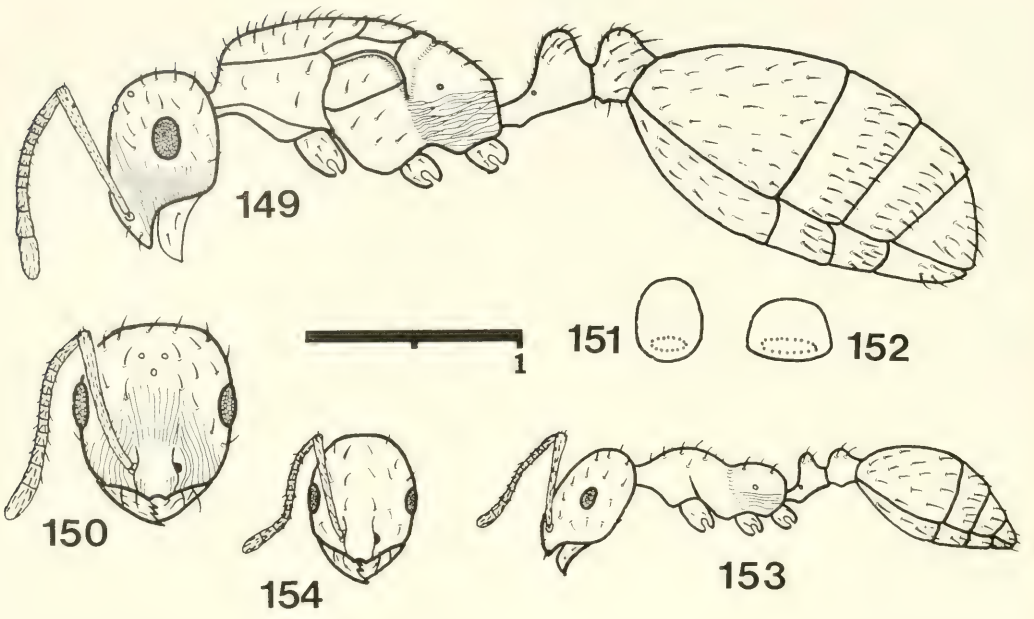
DIAGNOSIS. QUEEN: Winged; petiole as in Figures 149 and 151; scutum and scutellum not depressed; metanotum (in lateral view) projecting to level of propodeum and scutellum; propodeum angular (basal face 2X length of declivitous face). WORKER: Propodeum angular (basal face 2X length of declivitous face); mesopleuron not punctuate; petiole as in Figure 153; PI 35-38 (36).

DESCRIPTION. As described for *M. minimum* except as follows. QUEEN: *HEAD: Measurements* (representing type locality; $N=3$) HL 0.75-0.81 (0.78) {0.81}, HW 0.64-0.68 (0.67) {0.68}, SL 0.52-0.61 (0.56) {0.61}, IOD 0.16-0.18 (0.17) {0.17}, OD 0.04-0.05 (0.05) {0.05}, EL 0.16-0.22 (0.19) {0.22}, MOD 0.12-0.17 (0.14) {0.17}. *Structure*—CI 84-87 (85) {84}, SIL 67-75 (72){75}, SIW 76-90 (84){90}. Side of head straight. Scape reaching or surpassing occiput by less than length of pedicel. *Pilosity*—Setae erect to subdecumbent on clypeus, frons, gular region, mandible, and occiput, decumbent to appressed elsewhere. *Sculpture*—Small, parallel, longitudinal rugae beginning all along lateral margin of clypeus, extending past antennal insertion, and converging with frontal carina. Several small, parallel, longitudinal rugae beginning between clypeal teeth, extending to level of antennal insertion. Several small, parallel, longitudinal rugae beginning between frontal carinae (near posterior edge of carinae) and extending towards (but not reaching) anterior ocellus (Fig. 150). *ALITRUNK: Measurements* PW 0.40-0.48 (0.43){0.48}, PL 0.26-0.40 (0.34) {0.26}, WL 1.30-1.40 (1.35) {1.30}. *Structure*—Mesopleural suture deflected dorsally at each end (resulting in U-shaped suture), with pits lacking on both ends. Propodeum angular, basal face 2X length of declivitous face. PI 20-30 (26){20}. *Pilosity*—Fewer than 30 erect to suberect setae projecting above dorsal outline of alitrunk. *PETIOLE:* As in Figures 149 and 151. Setae appressed on anterior surface of node, suberect to erect (a few decumbent) on side, dorsum, and posterior surface of node, absent elsewhere. *POSTPETIOLE:* As in Figures 149 and 152. Setae appressed on anterior surface of node, suberect to erect elsewhere (including venter). Anterior surface and dorsum of node smooth and shining with small piliferous punctures; remainder covered with, moderately dense, non-piliferous punctures. *GASTER:* Setae of first gastral tergite not reaching level of dorsum of postpetiolar node. *COLOR:* Head (including mandible and antenna) brown to dark brown. Alitrunk brown to dark brown, legs brown to yellow brown. Petiole, postpetiole, and gaster brown to dark brown. All setae white.

MALE: UNKNOWN IN *M. marjoriae.*

WORKER: *HEAD: Measurements* (representing type locality; $N=2$) HL 0.55-0.61 (0.58), HW 0.45-0.46 (0.46), SL 0.41-0.45 (0.43), EL 0.08-0.09 (0.08), MOD 0.05-0.06 (0.06). *Structure*—CI 75-82 (78), SIL 74-75 (74), SIW 89-98 (94). Scape reaching or surpassing occiput by an amount less than length of pedicel. *Pilosity*—Setae erect to subdecumbent on clypeus, frons, gular region, mandible, and occiput, decumbent to appressed elsewhere. *ALITRUNK: Measurements* PW 0.26-0.28 (0.27), PL 0.24-0.25 (0.24), WL 0.65-0.68 (0.66). *Structure*—Propedeum angular, basal face 2X length of declivitous face. PI 35-38 (36). *POSTPETIOLE:* As in Figure 153. Moderately dense, non-piliferous punctures on posterior surface of node. *COLOR:* Head brown to dark brown, mandible and antenna brown to yellow brown. Alitrunk brown, legs yellow brown to yellow. Petiole, postpetiole, and gaster brown to dark brown. All setae white.

TYPE MATERIAL. HOLOTYPE QUEEN: *MEXICO: Nayarit;* Punga, May 26, 1923, H. C. Millender. Holotype (NMNH) bears red, handwritten label: *Monomorium/ marjoriae/* Holotype/ M. DuBois 1983/. Two paratype queens and 9 paratype workers collected with holotype. All paratypes bear



FIGS. 149-154. *Monomorium marjoriae.* 149—Queen, lateral view. 150—Head of queen, frontal view. 151—Petiole of queen, posterior view. 152—Postpetiole of queen, posterior view. 153—Worker, lateral view. 154—Head of worker, frontal view. *Scale:* (1 mm) for Figures 149-154.

blue, handwritten labels: *Monomorium/ marjoriae/* Paratype/ M. DuBois 1983/.

ETYMOLOGY. This species is named in honor of my mother, Marjorie A. (Black) DuBois.

DISTRIBUTION. This species is known only from the type locality listed above.

DISCUSSION. Monomorium marjoriae is most likely to be confused with *M. cyaneum* or *M. compressum* which may occur in similar habitats. Additionally, *M. marjoriae* closely resembles *M. ebeninum* in habitus; however, these species do not appear to overlap. Queens of *M. marjoriae* may be separated from those of *M. compressum* and *M. ebeninum* since in the latter two species the scutum and scutellum are concave or flat. Queens of *M. marjoriae* may be separated from those of *M. cyaneum* since the latter are wingless and the former have a propodeum with the length of the basal face 2X the length of the declivitous face. Workers of *M. marjoriae* may be separated from workers of these other species since they possess a propodeum with the basal face length 2X the declivitous face length.

Monomorium talbotae DuBois

Figures 155-163

Monomorium sp.: Talbot, 1975: 245; Talbot, 1979: 88; DuBois, 1980: 626.
Monomorium talbotae DuBois, 1981a: 31-34.

DIAGNOSIS. FEMALE: Winged; petiole convex (Fig. 155); scutum and scutellum convex; metanotum (in lateral view) not projecting to level of propodeum and scutellum; propodeum rounded; clypeus scarcely emarginate, lacking teeth; anterior edge of scutum not projecting over pronotum; no depression on first gastral tergite. MALE: Genitalia and sterna as in Figures 156, and 160-163.

DESCRIPTION. As described for *M. minimum* except as follows. FEMALE: *HEAD: Measurements* (representing type locality; $N=8$) HL 0.40-0.48 (0.44), HW 0.39-0.43 (0.40), SL 0.31-0.36 (0.34), IOD 0.09-0.10 (0.10), OD 0.04-0.06 (0.05), EL 0.08-0.09 (0.09), MOD 0.05-0.06 (0.06). *Structure*—CI 81-98 (92), SIL 74-80 (77), SIW 80-92 (84). In full frontal view, head broadest at or a little below occiput. Eye small in size. Scape reaching or surpassing occiput by an amount less than length of pedicel. Mandible with two teeth; maxillary palp 1-segmented; labial palp 1-segmented. Clypeal teeth absent (emargination greatly reduced

where space between teeth should occur). *Pilosity*—Setae erect to suberect over entire surface of head. *Sculpture*—Entire surface of head smooth and shining with small to moderate piliferous punctures. *ALITRUNK: Measurements* PW 0.27-0.33 (0.32), PL 0.19-0.22 (0.21), WL 0.63-0.72 (0.68). *Structure*—Mesopleural suture deflected ventrally at posterior end. Metanotum (in lateral view) not projecting to level of propodeum and scutellum. Propodeum rounded, basal and declivitous faces of approximately equal length. PI 30-32 (31). Three to 5 hamuli on hindwing. *Sculpture*—Smooth and shining throughout with small piliferous punctures. *PETIOLE:* As in Figure 155. Setae erect to suberect on all surfaces except venter which lacks setae. Entire surface smooth and shining with small piliferous punctures. *POSTPETIOLE:* As in Figure 155. Dorsum of node convex. Anterior subpostpetiolar process enlarged into spine, located medially on venter. Setae erect to suberect on all surfaces, including venter. Entire surface (except dorsum of node) covered with small, dense, non-piliferous punctures. Dorsum of node smooth and shining with small piliferous punctures. *GASTER:* Setae of first gastral tergite not reaching level of dorsum of postpetiolar node. *COLOR:* Head and mandible light brown. Alitrunk and legs light brown, except for light yellow tibiae and tarsi. Petiole, postpetiole, and gaster light brown. All setae white.

MALE: *HEAD: Measurements* (representing type locality; $N = 2$) HL 0.39-0.43 (0.41), HW 0.42-0.43 (0.42), SL 0.32-0.35 (0.34), IOD 0.07-0.08 (0.08), OD 0.04-0.05 (0.04), EL 0.09-0.10 (0.10), MOD 0.06-0.08 (0.07). *Structure*—CI 100-108 (104), SIL 81-82 (82), SIW 76-81 (79). Eye small in size. Mandible with 2 teeth (Fig. 157); maxillary palp 1-segmented (Fig. 159); labial palp 1-segmented (Fig. 158). Clypeal teeth and frontal carinae as in female. *Pilosity*—As in female. *Sculpture*—As in female. *ALITRUNK: Measurements* PW 0.29-0.30 (0.30), PL 0.20-0.22 (0.21), WL 0.63-0.68 (0.66). *Structure*—As in female. PI 32 (32). Wings as in female. *Pilosity*—As in female. *Sculpture*—As in female. *PETIOLE:* As in female. *POSTPETIOLE:* As in female. *GASTER:* As in female. *GENITALIA:* As in Figures 156 and 160-163. Eighth sternite with emargination approximately 1/2 as deep as wide (Fig. 162). Ninth sternite with 10-12 erect setae (Fig. 163). Aedeagus with 7 teeth; toothed margin straight (Fig. 161). *COLOR:* As in female.

WORKER: Unknown and apparently non-existent in *M. talbotae*.

TYPE MATERIAL. Type series consisting of 8 females and 2 males (DuBois, 1981a): *MICHIGAN: Livingston Co.*, E. S. George Reserve, 30 June 1966, M. Talbot. Holotype (MCZ) bears red, handwritten label: *Monomorium/ talbotae/* M. DuBois 1981/ Holotype/. Allotype male also in MCZ. Paratypes distributed as follows: 6 females, 1 male (MBDPC), 1 female (KU). Allotype and paratypes bear red, handwritten labels: *Monomorium/ talbotae/* M. DuBois 1981/ Paratype (or Allotype)/.

DISTRIBUTION. This species is currently known only from the type locality listed above.

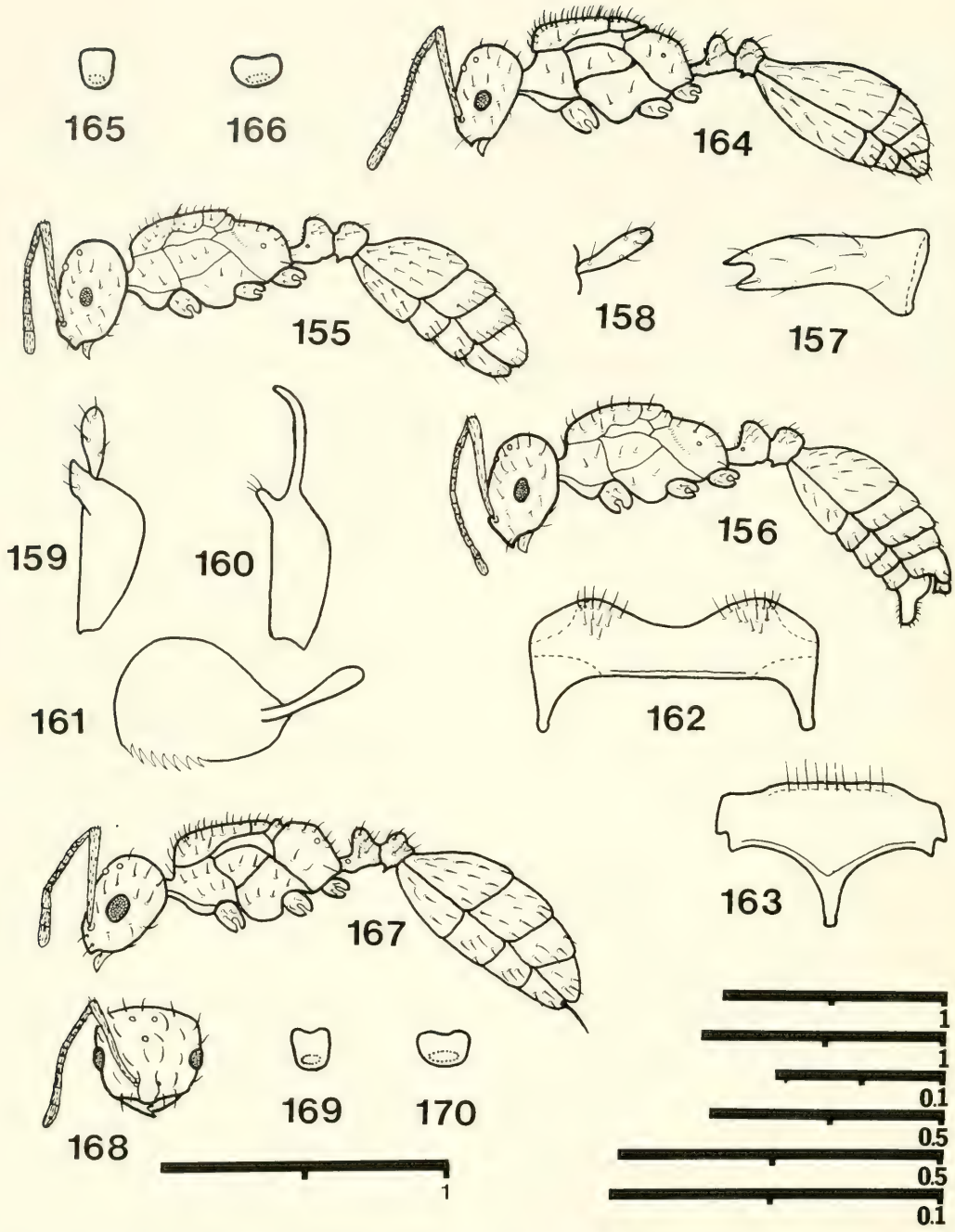
DISCUSSION. BIOLOGY. This species was discovered in three nests of *M. minimum*. It is presumed to be a social parasite in view of the morphological features it shares with other species of inquilinous *Monomorium* (see section on inquilinism). Habitat (from notes of M. Talbot): "A high, dry field where vegetation was not dense and small patches of bare sandy soil were numerous. Grasses were mostly *Poa compressa* and *Aristida* sp. A variety of scattered forbes included *Lespedeza capitata, Liatris aspersa, Rumex acetosella,* and *Solidago* spp. Patches of *Polytrichum piliferum* moss were large and frequent and the red-tipped lichen, *Cladonia cristatella* var. *vestita,* was characteristic." (DuBois, 1981a).

COMPARISONS. *Monomorium talbotae* specimens are easily recognized by the relatively small size of the female and male (compared to the size of host male and female) and by their smooth and shining integument. *Monomorium talbotae* females and males are most likely to be confused with those of *M. inquilinum* and *M. pergandei*. The first differs from both the other species since the metanotum does not reach the level of the propodeum and scutellum.

Monomorium pergandei (Emery)

Figures 164-166

Epoecus pergandei Emery, 1892 (1893): cclxxvi-cclxxvii; Emery, 1895: 272-274; Wheeler, 1910: 498; Emery, 1921: 204-205; Smith, 1943: 301-302; Smith, 1947: 569-570; Creighton, 1950: 239-241; Smith, 1952: 815.



FIGS. 155-163. *Monomorium talbotae.* 155—Female, lateral view. 156—Male, lateral view. 157—Mandible of male. 158—Labial palp of male. 159—Maxilla and maxillary palp of male. 160—Volsella of male. 161—Aedeagus of male. 162—Eighth sternite of male. 163—Ninth sternite of male. FIGS. 164-166. *Monomorium pergandei.* 164—Female, lateral view. 165—Petiole of female, posterior view. 166—Postpetiole of female, posterior view. FIGS. 167-170. *Monomorium inquilinum.* 167—Female, lateral view. 168—Head of female, frontal view. 169—Petiole of female, posterior view. 170—Postpetiole of female, posterior view. *Scales:* Left (1 mm) for Figures 167-170. Right top (1 mm) for Figures 164-166. Right second (1 mm) for Figures 155-156. Right third (0.1 mm) for Figure 157. Right fourth scale (0.5 mm) for Figures 160-161. Right fifth scale (0.5 mm) for Figures 162-163. Right bottom scale (0.1 mm) for Figures 158-159.

Monomorium pergandei: Ettershank, 1966: 82-91; Wilson, 1971: 354; Smith, 1979: 1383; DuBois, 1981a: 36.

DIAGNOSIS. Female: Winged; petiole as in Figures 164 and 165; scutum and scutellum convex; metanotum (in lateral view) projecting above level of propodeum and scutellum; propodeum angular; clypeus emarginate, teeth blunt and reduced; anterior edge of scutum projecting over pronotum as in Figure 164.

DESCRIPTION. As described for *M. talbotae* except as follows. Female: *Head: Measurements* (representing type locality; $N = 2$) HL 0.44-0.48 (0.46), HW 0.39-0.40 (0.40), SL 0.40-0.42 (0.41), IOD 0.09-0.10 (0.10), OD 0.04-0.05 (0.04), EL 0.09-0.10 (0.10), MOD 0.08-0.09 (0.08). *Structure*—CI 83-89 (86), SIL 88-90 (89), SIW 103-105 (104). Scape surpassing occiput by an amount slightly greater than length of pedicel. Mandible with three teeth. Clypeal teeth blunt, short. *Alitrunk: Measurements* PW 0.30-0.33 (0.32), PL 0.22-0.28 (0.25), WL 0.72-0.81 (0.76). *Structure*—Mesonotum with small notal furrow. Scutum and scutellum not depressed. Anterior edge of scutum projecting over pronotum as in Figure 164. Mesopleural suture deflected dorsally at posterior end and ventrally at anterior end; smal pit at each end. Metanotum (in lateral view) projecting above level of propodeum and scutellum. Propodeum angular. PI 30-35 (32). *Petiole:* As in Figures 164 and 165. Dorsum of node flat, smooth and shining with small piliferous punctures. Remaining surfaces covered with moderately dense, non-piliferous punctures. *Postpetiole:* As in Figures 164 and 166. Dorsum of node weakly emarginate. *Gaster:* As in *M. minimum* except as follows: first gastral tergite with basal depression. *Color:* Head brown to dark brown except as follows: mandible and antenna yellow brown to yellow. Alitrunk brown, legs yellow brown to yellow. Petiole, postpetiole, and gaster brown. All setae white.

Male: Although males and females of *M. pergandei* were collected from the same nest, no male specimens could be located for this study. One badly damaged specimen (gaster missing) is labelled as a male in the NMNH collection. The head and alitrunk resemble those of a female. This may actually be a male if the sexes in *M. pergandei* are as similar as they are in *M. talbotae.*

Worker: Unknown and apparently non-existent in *M. pergandei.*

TYPE MATERIAL. Type series consisting of lectotype and 6 paralectotype queens, designated by DuBois (1981a): *District of Columbia:* Washington, 12 July (year unknown but before 1892), T. Pergande. Lectotype and 4 paralectotypes in NMNH, remaining paralectotypes in MCZ. All specimens bear red, handwritten labels: *Monomorium/ pergandei/* Lectotype (or Paralectotype)/ M. DuBois 1980/.

DISTRIBUTION. This species is known only from the type locality.

DISCUSSION. Biology. This species was discovered in a nest of *M. minimum.* It is presumed to be a social parasite in view of the morphological features it shares with other species of inquilinous *Monomorium* (see section on inquilinism).

This species has only been collected once (almost 100 years ago), and is probably now extinct. One detail recorded, and perpetuated through the literature (i.e., Wheeler, 1910: 498; Creighton, 1950: 239-241), was that when the colony containing *M. pergandei* was taken to the laboratory, Pergande noted that reproductives of *M. minimum* were also present in the nest. As he watched, the *M. pergandei* females attacked and killed some of the *M. minimum* males. This seems rather unusual behavior if the reproductives of the two species coexisted previously in the same nest. However, Wheeler (1910: 498) points out that Pergande may have collected two colonies in close proximity to each other, with one colony containing *M. pergandei* reproductives and *M. minimum* workers, while the other colongy contained *M. minimum* reproductives. Wheeler then supposed these two colonies were combined in the laboratory and the observed behavior ensued.

Comparisons. *Monomorium pergandei* is easily recognized by the small size of the female (compared to the size of the host), the smooth and shining integument, the abundance of erect to suberect setae over most of the body, the spine projecting where the postpetiolar process is usually located, and the large depression on the dorsum of the first gastral tergite.

Females of this species are most similar

to *M. inquilinum*. However, these two species can easily be separated, since the metanotum only projects to the level of the propodeum and scutellum and there are only two mandibular teeth in *M. inquilinum*. The petiolar node is flat and the anterior edge of the scutum does not project over the pronotum in *M. inquilinum*. These same characters distinguish females of *M. talbotae*, which also lack a dorsal impression on the first gastral tergite.

Monomorium inquilinum DuBois

Figures 167-170

Monomorium sp.: DuBois, 1980: 626.
Monomorium inquilinum DuBois, 1981a: 34-36.

DIAGNOSIS. FEMALE: Winged; petiole emarginate (Fig. 167); scutum and scutellum not depressed; metanotum (in lateral view) projecting to level of propodeum and scutellum; propodeum angular; clypeus emarginate, lacking teeth; anterior edge of pronotum rounded.

DESCRIPTION. As described for *M. talbotae* except as follows. FEMALE: *HEAD: Measurements* {representing holotype only} HL 0.45, HW 0.39, SL 0.40, IOD 0.10, OD 0.04, EL 0.10, MOD 0.08. *Structure*—CI 89, SIL 89, SIW 100. Scape surpassing occiput by amount slightly greater than length of pedicel. Labial palp 2-segmented. Clypeal teeth absent (clypeus retaining emargination where space between teeth should occur). *ALITRUNK: Measurements* PW 0.30, PL 0.15, WL 0.66. *Structure*—Mesopleural suture straight. Metanotum (in lateral view) projecting to level of propodeum and scutellum. Propodeum angular, basal face length half length of declivitous face. PI 22. Wings absent (presence of basal sclerites indicate holotype once possessed wings). *Pilosity*—As in *M. cyaneum*. *Sculpture*—As in *M. talbotae*. *PETIOLE:* As in Figures 167 and 169. Dorsum of node emarginate. Entire surface (except dorsum of petiolar node) covered with small, dense, nonpiliferous punctures (causing a granular appearance); dorsum of node smooth and shining with small piliferous punctures. *POSTPETIOLE:* As in Figures 167 and 170. Dorsum of node emarginate. *GASTER:* As in *M. pergandei*. *COLOR:* Head dark brown, antenna yellow. Alitrunk dark brown, legs brown (tibiae and tarsi yellow). Petiole, postpetiole, and gaster dark brown. All setae white.

MALE: Unknown in *M. inquilinum*.

WORKER: Unknown and apparently non-existent in *M. inquilinum*.

TYPE MATERIAL. Known only from the holotype (DuBois, 1981a): *ESTADO DE MEXICO:* Highway 57 (between Mexico City and Queretaro), km 127 (measured from Mexico City), high desert, Cornell University Mexico Field Party, 9 August 1965 (1 female, MCZ).

DISTRIBUTION. This species is known only from the type locality.

DISCUSSION. BIOLOGY. This species was discovered in a nest of *M. cyaneum* beneath a stone. It is presumed to be a social parasite because of the morphological features shared with other inquilinous *Monomorium* (see section on inquilinism).

COMPARISONS. The *Monomorium inquilinum* female is most similar to *M. pergandei* and *M. talbotae* females. It can be easily be separated from these species since the petiole is emarginate only in *M. inquilinum*. Furthermore, the metanotum does not reach the level of propodeum and scutellum in *M. talbotae*, and the mesonotum possesses a furrow in *M. pergandei*.

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Larvae of the Crane Fly Genus *Tipula* In North America (Diptera: Tipulidae)

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Jon K. Gelhaus

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Larvae of the Crane Fly Genus *Tipula* in North America (Diptera: Tipulidae)[1]

Jon K. Gelhaus

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[1] Contribution No. 1948 from the Department of Entomology, The University of Kansas, Lawrence, Kansas, 66045, U.S.A

ABSTRACT

This is a taxonomic study concerning larvae of the crane fly genus *Tipula*. Descriptions and illustrations are given for larvae of at least one species in 20 of the 27 recognized nearctic subgenera; for four of these groups, larvae are described for the first time. A key is presented to the subgenera of *Tipula* and to certain similar genera for final-instar larvae. External morphology, concentrating on the diversity found among the subgenera, and various rearing methods are discussed. Included in each subgeneric treatment is a discussion of the characters of the group, and a list of known habitats.

Larvae of *Tipula* occupy a wide range of aquatic to terrestrial situations and the morphology correspondingly varies among the subgenera. Overall, larval groups are in agreement with the adult subgeneric classification, although the subgenus *Trichotipula* contains two extremely different types of larvae. No unique characters of the larvae were found to unify the entire genus, but certain groupings of subgenera have distinctive sets of characters. Some groups within the genus are more similar morphologically to other tipuline genera, such as *Holorusia* and *Prionocera,* than to many other subgenera of *Tipula.*

INTRODUCTION

At the time of Alexander's comprehensive 1920 paper, "The Crane-flies of New York. Part II. Biology and Phylogeny," the larvae of only four percent (16 species) of the nearctic species of *Tipula* had been described. From 1920 to 1983, the larvae of only five additional nearctic species were described and illustrated, and the life history of only one species was studied in any detail. My work represents a step toward correcting this lack of knowledge about this diverse genus, including descriptions of larvae and information about their biology.

The cosmopolitan genus *Tipula* contains approximately 450 nearctic species placed in 27 subgenera (Alexander, 1965). *Tipula* larvae are by nature of their habitat inconspicuous, although the larval stages may last from six months to five years. Larvae can be sufficiently abundant locally to have an appreciable ecological impact. The larval habitats vary tremendously within the genus. Larvae of some species are fully aquatic and are found in leaf packs or on the bottoms of streams (e.g., *Nippotipula*), while others occur in the wet soil of stream and lake margins, seepages, algal mats or wet mosses (e.g., *Yamatotipula*). Many species such as those in *Lunatipula* are found in soil under layers of leaf mold or other decaying vegetation in forested areas. Some species (e.g., *Serratipula*) are in the soil of pastures or meadows, where they feed on roots and leaves of young grasses. A few of these may become pests in favorable years by denuding hundreds of acres of rangeland, thus earning the common name "range crane fly." Some larvae are found in dead wood at various stages of decay (e.g., *Pterelachisus*). Still others, such as *Eremotipula* (inferring from pupal collections), occur in semiarid areas in the soil under rabbitbrush *(Chrysothamnus)* and other shrubs. All species appear to be herbivorous or to feed on decaying plant matter.

Existing keys, most recently by Alexander and Byers (1981), will at best identify larvae of nearctic *Tipula* to the generic level, and certain species of *Tipula* cannot even be distinguished from other genera of Tipulinae by these keys. All 42 subgenera are based exclusively on adult characters, and in the present study, inconsistencies are seen between adult and larval groupings in certain subgenera (e.g., the two larval types of the subgenus *Trichotipula*).

I have examined reared material for as many species as possible (approximately 70 species, 16 percent of the genus in the Nearctic) to ascertain the characters for each subgenus. Larvae were obtained for 20 of the 27 nearctic subgenera, and for four of these subgenera *(Bellardina, Hesperotipula, Serratipula* and *Sinotipula)* the larvae are here described for the first time. A key to the subgenera is included, as well as information on larval biology.

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Reared and associated larvae and adults of *Tipula* are not often encountered in museum collections; therefore, everyone who contributed specimens has added significantly to this work. The collection of J. Speed Rogers at the University of Michigan (UM), Ann Arbor, contains many specimens reared by Rogers; it also includes the specimens used by C. P. Alexander in his 1920 paper. I thank T. E. Moore, curator of the Michigan collection, for the loan of this important material. Thanks also go to H. J. Teskey, Canadian National Collection (CNC), Ottawa, for the use of his extensive collection from eastern North America. I also used specimens from the following museums: Dept. of Entomology, American Museum of Natural History (AMNH), Entomology Museum, University of California at Riverside (UCR), Entomological Museum, North Carolina State University (NC) and the James Entomological Collection, Washington State University (WSU). Other specimens are from the Snow Entomology Museum, University of Kansas (KU), State Biological Survey of Kansas collection (SBSK), and from my personal collection (JKG). Other individuals provided certain species or other help and deserve acknowledgement: S. A. Teale (ST), State University of New York, Syracuse, identified many of my reared adult *Tipula* from the Rocky Mountains and loaned specimens of *T. platymera;* G. Pritchard (GP), University of Calgary, Alberta, sent specimens of *T. commiscibilis* and *sacra;* F. B. Brodo, Carleton University, Ottawa, loaned larvae of the genus *Prionocera,* which allowed me to separate *Prionocera* from the subgenus *Angarotipula;* H. M. Knizeski (HK), Mercy College, Dobbs Ferry, New York, provided specimens of *T. ignobilis;* and P. Oosterbroek, Institute of Taxonomic Zoology, University of Amsterdam, spent a number of hours helping me translate the 1957 paper of B. Theowald. Financial costs for museum visits and fieldwork were partially defrayed by two awards from the Raymond H. Beamer Memorial Fund, University of Kansas.

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Materials and Methods

Larvae of 68 species of *Tipula* and of *Holorusia rubiginosa* and *Prionocera dimidiata* were examined. I have reared 37 of these species one or more times. I collected larvae primarily in eastern Kansas, northern New Mexico and central California; most other collections studied were made in eastern North America.

The diversity of habitats occupied by larvae of *Tipula* requires a variety of collection methods. Details are given by Gelhaus (1983). A sturdy garden trowel is indispensable for collecting in aquatic and terrestrial situations. Uses include clearing aside soil in forest situations; digging up saturated soils bordering aquatic habitats for sieving; or dislodging gravel and rocks on the bottom of fast-flowing streams and rivers. Both a D-frame aquatic net and forceps have limited use when collecting larvae of *Tipula.* The D-frame net is desirable when larvae inhabit leaf packs (e.g., *Nippotipula*) or are under rocks in rivers and streams (e.g., *Sinotipula*). Heavy forceps are needed for hand collecting in aquatic habitats that are too small for D-nets or sieves, such as shallow seepages or springs. Detailed examination of mosses or soft, rotting logs requires forceps.

As briefly discussed by Brindle (1960c), the use of a sieve when collecting in saturated soils is highly recommended, as larvae are cryptically colored, slow moving and easy to overlook when only hand collecting with forceps. A 1 mm mesh screen is adequate for retaining all late-second instar and older larvae (Brindle suggests 1/16 of an inch). When sieved, a larva usually curls up for a short time, or if small and very active, it may move through the sieve mesh. A sieve works best in fine, sandy areas; it is not as efficient in heavily organic areas with large amounts of plant debris. In all cases, though, sieving reduces the amount of material to be sorted through and washes debris from the larvae, making them more visible.

Terrestrial and semiaquatic larvae almost always live within 50 mm of the substrate surface, regardless of climatic conditions. Larvae of the related genus *Dolichopeza* remain near the surface even during the winter when their habitat is frozen (Byers, 1961), and I have observed similar behaviors in larvae of the subgenera *Luna-*

tipula, Pterelachisus and *Vestiplex.* Hot, dry summer weather also does not appear to force larvae to move deeper into the substrate. *Tipula (Trichotipula) stonei,* in fact, develops and matures during the summer, and even during a prolonged drought, larvae were found in the top 30-50 mm of dry forest soil. *Tipula (Lunatipula) oxytona* moves downward to 200 mm during dry periods (Rogers, 1933), but this appears to be an exceptional instance and may be related to this species' occurrence in sandy soils which rapidly lose moisture near the surface.

For species whose larval habitat is unknown, certain predictions can be made by observing the behavior of the adults or by knowledge of larval habitats for related species. Adults may occur away from the specific larval habitat. Teneral adults or ovipositing females give a clearer idea of where larvae occur, as does the activity of males seeking newly emerged females. Pupal collections are useful, for pupae occur near the larval habitat or even among the larvae. In species with highly synchronous adult emergences, however, once pupae are found, few individuals will remain as larvae, and a return visit is required during the next generation to secure larvae.

Snap-cap glass vials (60 ml), one-third filled with soil or other habitat material and each with only one or two larvae, are excellent for field use and allow larvae to be easily recovered once in the laboratory. Self-sealing plastic bags are excellent for transporting larvae over a long time period, when many larvae are found in one specific site, or if associated soil or debris from the larval habitat is needed for rearing or sieving in the laboratory. The bags should be one-third to one-half filled with substrate from the larval habitat. The collections are then kept cool until brought into the laboratory, as even short periods of heat (as in a vehicle on a warm day) will kill the larvae. Larvae from aquatic habitats should be transported in damp debris, mosses or leaf litter; although from an aquatic habitat, they are susceptible to drowning.

A single microhabitat may yield more than one species of larvae; therefore, larvae should be carefully sorted before placement in rearing chambers. Larvae often expose the spiracular discs at the surface when placed in water, permitting identification in life with a microscope. Chilling the larvae for a few minutes helps if they are very active.

A proper rearing container must admit fresh air and maintain an even moisture level. Both Chiswell (1956) and Byers (1961) recommended Petri dishes, but I found such dishes of limited use. Petri dishes have a small volume, are easily kept too wet, but also quickly dry out. The small volume also allows overcrowding even when there are only a few larvae per dish. Petri dishes are advantageous for observations of larval behavior, but for rearing, I prefer glass containers 40-80 mm high and 100 mm diameter. Such jars hold enough food (i.e., leaf litter, rotting wood, etc.) from the habitat to allow late-third or fourth-instar larvae to develop to the pupal stage. Moreover, they do not require daily checking for food depletion and moisture control. Aquatic species need only wet litter or, at most, a small amount of free water; terrestrial species should be kept just damp. Ideally, one larva should be kept per container; practically, I have kept up to six larvae per jar.

All *Tipula* reared have been herbivorous or saprophagous. Wet, decaying leaves for aquatic species and damp leaves or debris for terrestrial larvae suffices for most; some species of *Yamatotipula, Platytipula* and *Triplicitipula* will accept and feed readily on young green shoots of common weeds (Young, 1981; Gelhaus, personal observation). When conditions are adequate, larvae remain buried within the debris or soil during the day.

Although in most cases it is best to try to duplicate the natural conditions of the larval habitat in the laboratory, in some situations this is not desirable. It is not necessary to maintain species from rapidly flowing streams or rivers, such as some *Sinotipula* or *Nippotipula,* in constantly aerated water. Gordon Pritchard *(in litt.)* reared larvae of *T. (Sinotipula) commiscibilis* in containers of wet leaves at 15 degrees C., although they were originally collected from a fast-flowing, cold, mountain stream. Many species are influenced by photoperiod, particularly when about to pupate; they should be exposed to a source of natural light or to artificial light of similar periodicity (e.g., *Platytipula*).

Since a female *Tipula* may lay 200-300 eggs, rearing larvae from eggs would appear to be ideal for obtaining many larvae of a single species. Unfortunately, the life histories of many species cause problems in rearing and in maintaining laboratory cultures. Some mated females are reluctant to lay. Although pinching the cervical region of the female will often induce egg laying, it is not reliable. Eggs of many species undergo an obligate diapause that is broken only when they are exposed to certain photoperiods, temperatures or moisture conditions. For example, Hartman and Hynes (1977) found that the eggs of *T. (Triplicitipula) simplex* would only hatch after exposure to a certain photoperiod and alternating wet and dry conditions. I found that eggs of an undescribed

species of *T. (Platytipula)* only hatched after exposure to cold and typical winter photoperiods. Other groups have eggs which hatch soon after being laid (approximately one week). Subgenera with brief egg stages include *Nippotipula, Bellardina* and most species of *Yamatotipula*. Eggs of *T. (Nobilotipula) nobilis* had no apparent diapause but took approximately three weeks to hatch. Eggs of *Lunatipula, Pterelachisus* and *Savtshenkia* appeared to have a developmental diapause but the cues breaking the diapause are unknown.

First-instar larvae have a high initial mortality, and many eggs never hatch. After larvae start feeding, though, provided food depletion and overcrowding are prevented, mortality is minimal and they usually develop rapidly. For example, *T. (Yamatotipula) tricolor* completed a generation in 69 days in the laboratory.

As larvae reach maturity, it is important to watch for inactive larvae or teneral pupae. As noted by Byers (1961) for the tipuline genus *Dolichopeza,* larvae prior to pupation are contracted and inactive. As the pupal molt becomes imminent, the larval head is deflected ventrally and pupal structures become visible through the larval cuticle. Most aquatic larvae leave the water to pupate in drier soil; most pupae immersed in water quickly die. Some species have an obligate, fourth-instar, larval diapause in which they remain contracted and inactive during the summer. I have observed this prepupal diapause in certain species of *Yamatotipula* (e.g., *T. sayi*), all reared species of *Platytipula* and *T. (Nippotipula) abdominalis*.

The best association of immature and adult stages of a species is from the last larval skin, pupal skin and emerged adult of a single individual. All the morphological characters that are needed for identification can be located on the shed skins and there is little likelihood of an erroneous association. The last larval skin is usually found near the posterior end of the pupa and may be crumpled into a compact mass. If found within one or two days after pupation (pupa will still be white or light brown), the skin can be easily stretched and cleaned in water. If the skin does not tear easily when stretched or is known to have been recently shed, I place it in water in an ultrasonic cleaning appliance and vibrate it for 10-15 seconds. The cleaned skin is then quickly restretched and stored in 70-80 percent alcohol to which a small amount of glycerin has been added.

Soon after the first pupae are found, I preserve some of the remaining larvae. Chiswell (1956) and Brindle (1960c) recommend preserving larvae in Pampel's fluid, but I have found that it is satisfactory to kill larvae by pouring water near the boiling point on them, then transferring them to storage in alcohol. This heat treatment is necessary for the expansion of the spiracular disc. Killing larvae in alcohol is unsatisfactory and results in shrunken, contracted specimens. I rarely preserve larvae in the field but, when necessary, Kahle's solution gives reasonably good specimens. Before storage in alcohol, killed larvae should be placed in the ultrasonic cleaning appliance for 10-15 seconds to remove fine dirt particles.

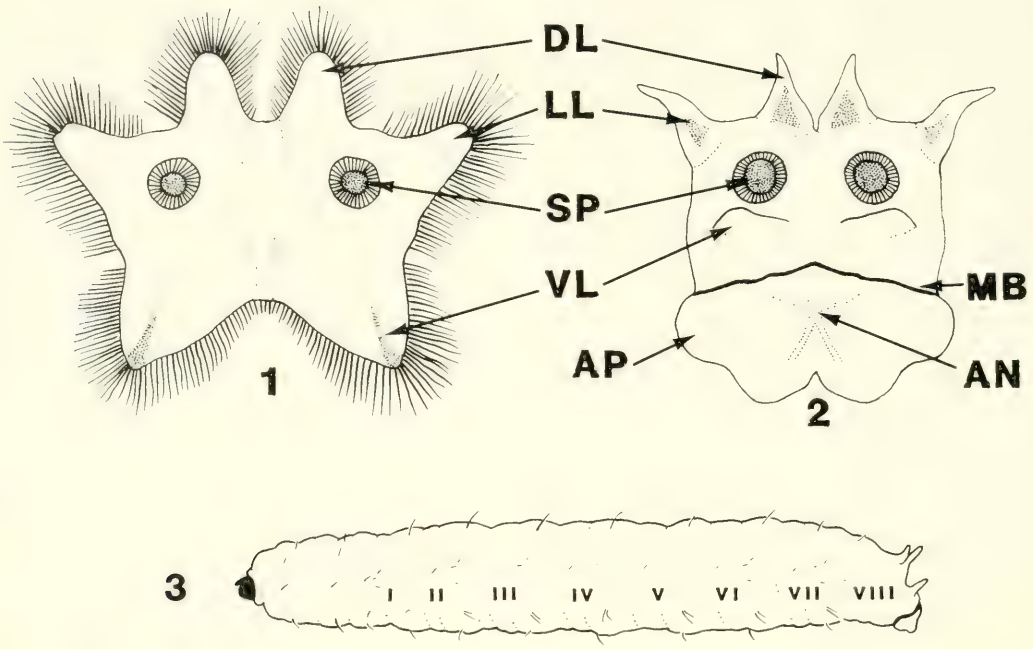
Pupae should usually be isolated from larvae, particularly if the rearing container is crowded. Pupae are delicate and should be handled as little as is possible. They can be transferred to a layer of fine damp sand or soil in a large vial with a loose fitting cap. The emerging adult needs a vertical space at least twice the length of the pupa to develop and expand properly. Once the adult has emerged, the pupal skin can be soaked for 5-10 minutes in water, then washed in a stream of water or placed in the ultrasonic vibrator. Unlike the debris on a larva or larval skin, dirt on a pupal skin is difficult to remove completely.

MORPHOLOGY

Larvae of *Tipula* are elongate and cylindrical, tapering slightly at the cephalic end (Fig. 3). Mature larvae range from 12 to 60 mm in length. The black head is only partially visible, as the larval skin is attached near the anterior end of the head. The posterior end of the larva has short to long lobes surrounding two conspicuous spiracles. Beneath this spiracular area are often whitish lobes, varying in number and length, surrounding the anus. The body varies from white to brown, occasionally having a pinkish tint. Tufts of hairs and dark setae may also be seen, or the larva may appear completely hairy. Sometimes there are patterns of longitudinal lines or spots on the abdomen.

The head varies slightly from group to group, and the characters that vary are not well-suited for identification purposes. It is not described for any of the taxa treated here. A treatment of the head and its parts is found in Chiswell (1955) for *Tipula* and in Byers (1961) for a related genus, *Dolichopeza*.

Three thoracic and eight abdominal segments are clearly visible, although there are actually ten abdominal segments, according to Byers (1961). The obvious segments can be recognized by the transverse row of setae found on each segment, dorsally and ventrally. The prothoracic segment has two rows of dorsal setae, but this does not indicate two segments (Byers,



Figs. 1-3. General morphology of *Tipula* larvae. 1, spiracular area, aquatic larva. 2, spiracular area, terrestrial larva; AN-anus, AP-anal papilla, DL-dorsal lobe, LL-lateral lobe, MB-marginal band, SP-spiracle, VL-ventral lobe. 3, *T. stonei,* lateral aspect, abdominal segments I-VIII labelled; length 18 mm.

1961:734). Abdominal segment IX contains the spiracles and the immediately surrounding region. The anus and the perianal region constitute abdominal segment X, as in the adult. Abdominal segments I-VIII each appears subdivided, with a large, anterior portion (annulus) and a narrow, posterior section containing the dorsal and ventral macrosetae (Figs. 3, 16).

The cuticle is tough, hence the common name, "leather-jackets." Strong sclerotization is almost always restricted to the lobes surrounding the spiracles; the one exception is in the *T. (Lunatipula) disjuncta* group, in which dark sclerites extend from the lobes onto the dorsum of abdominal segment VIII (Fig. 56). The cuticle itself is light brown; any darker regions are caused by concentrations of hairs.

Chiswell (1956) was the first to treat the macrosetae in detail. He illustrated setal arrangements for various genera of Tipulinae and consistently applied a numbering system for the setae which I have adopted here; the homologues can be traced from genus to genus.

When specimens are roughly handled, the macrosetae can be broken off. Although the positions of broken setae can be determined from the basal sockets, information concerning setal length, thickness, and color is lost. Breakage is a primary reason for concentrating on abdominal setal arrangements; thoracic arrangements are found on only three segments, with the same arrangement repeated on the mesothorax and metathorax. In contrast, abdominal arrangements are repeated on the first seven abdominal segments, so that breakage is less of a problem.

Macrosetae of aquatic larvae are long, thin, light to dark brown (Fig. 9), and may be obscured by dense hairs. Certain aquatic groups possess setae that are branched (setae D6, L3, V1), with the distal halves of these setae divided into two to four branches (Figs. 9, 66). Branched setae have not been noted or illustrated by other authors, although groups in which the setae occur have been described.

Macrosetae of terrestrial larvae are almost always short, thick and dark brown to black (Fig. 81). Larvae of the *T. (Lunatipula) disjuncta* group and of subgenus *Odonatisca* are notable exceptions as the setae are elongate and yellow (Fig. 53). Because of the lack of long hairs on terrestrial larvae, the macrosetae are not usually obscured by hairs.

The arrangement of setae often differs be-

tween groups, but seems to be constant within a group (or, at least, within a particular species). Three sets of setae are present on each abdominal segment: dorsal, ventral and pleural. The dorsal and ventral setal arrangements are bilaterally symmetrical. Generally, there are six pairs of dorsal setae in two rows (Fig. 4a), five pairs of ventral setae in two rows (Fig. 4b), and four pleural setae (Fig. 4c). Seta L3 is below seta L2 and seta L1 is most often behind seta L2, but in *Nobilotipula* and the palearctic *T. (Platytipula) melanoceros* these three setae are in vertical alignment (Fig. 67).

Most aquatic or semiaquatic larvae possess the full complement of setae, but reduction in setal size, or complete absence of certain setae, is frequently seen in terrestrial larvae (e.g., Figs. 37, 54). Setae D4, D5, L1, L3, V1 and V5 are often considerably shortened and setae D5 and V1 are occasionally absent.

In addition to macrosetae, larvae of *Tipula* exhibit various kinds, sizes and patterns of finer hairs. Hairs are found on every segment except part of abdominal segment IX and most of segment X. The thoracic segments are usually covered by rather uniform, appressed silky hairs which provide no useful characters. On the other hand, hairs on abdominal segments I-VII exhibit much variation between groups and have been used in this study. On segment VIII and on the spiracular lobes they are usually long and uniform; hairs on the pleura are scattered and usually very short.

The hairs can be separated into three groups: macroscopic hairs, long microscopic hairs and short microscopic hairs. An idea of their sizes in relationship to each other and to macrosetae can be obtained from Figs. 105 and 147. In almost all larvae, the hairs are cylindrical and narrow, without longitudinal ridges, and usually dull brown (Fig. 8). In *Nobilotipula,* however, they are flattened, relatively broad, with longitudinal ridges and are reflective (Figs. 70, 71).

Macroscopic hairs are easily seen under low magnification and often equal or exceed the length of the macrosetae. They can be distinguished from setae because hairs lack the distinctive basal sockets. Although usually single, macroscopic hairs are sometimes organized into clusters or tufts. Hair clusters are made up of many hairs and surround setae D4, D5 and V2 (Fig. 147). They also may be found on abdominal dorsum VIII of *Yamatotipula* and other groups (Fig. 151) or on the apices of the spiracular and accessory lobes of *Nippotipula* (Fig. 60). They also form distinctive abdominal patterns in certain species of *Yamatotipula* (e.g., *pruinosa,* see Chiswell, 1956). Hair tufts are found only in the subgenus *Tipula* and are made up of a few, closely set dark hairs located near setae D5 and V2 but not surrounding them (Figs. 116, 117). The predominance of macroscopic hairs varies with the group but they are usually abundant only in aquatic larvae. For example, larvae of the subgenus *Angarotipula* and the *T. (Trichotipula) oropezoides* group are covered almost exclusively with these hairs (Figs. 8, 124). In *Schummelia,* they form a semicircular band on the dorsum of abdominal segment VIII (Fig. 98).

Short microscopic hairs are always organized into groups, usually short to long, transverse

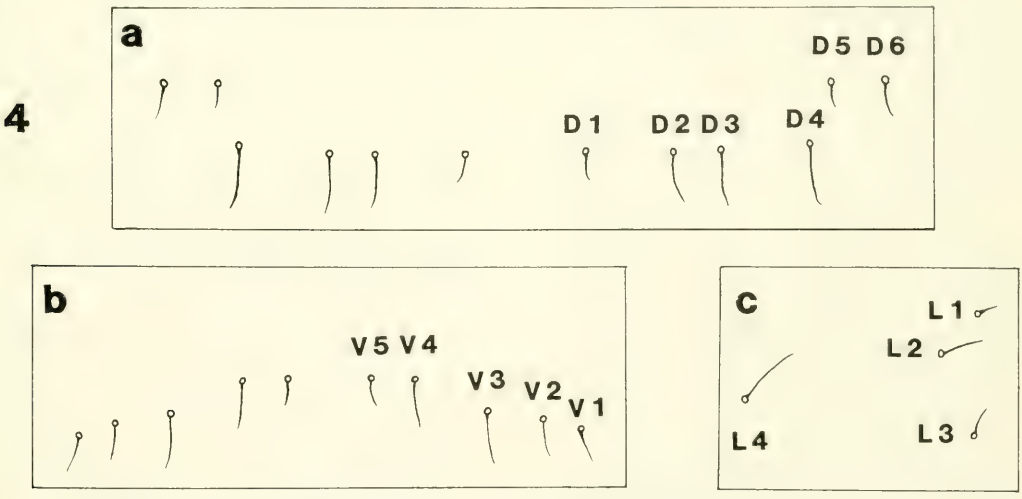


Fig. 4. Abdominal macrosetal arrangements. a, dorsal setae. b, ventral setae. c, pleural (=lateral) setae.

rows (Figs. 40, 47), and individual hairs may be difficult to discern at lower magnifications. In most terrestrial subgenera, such as *Lunatipula* or *Pterelachisus,* the body is almost exclusively covered with these hairs; a similar condition is found in the aquatic subgenera *Nippotipula, Sinotipula* and *Arctotipula.* Short microscopic hairs are entirely absent in *Tipula (Trichotipula) stonei* and the subgenus *Schummelia.* Light and dark short hairs sometimes form contrasting patterns, e.g., a spotted pattern in *T. (Yamatotipula) caloptera* (Fig. 150), dark longitudinal lines in *T. (Y.) strepens* (Fig. 151) and irregular designs in *Sinotipula* (Fig. 111) and certain species of *Savtshenkia.*

Long microscopic hairs vary in length; usually they are much shorter than macroscopic hairs but sometimes are intermediate between macroscopic and short microscopic hairs. These long hairs are always single, unlike the short hairs, and are not found in most subgenera. All three classes of hairs occur together in *T. (Yamatotipula) strepens* (Fig. 147), but long microscopic hairs predominate in *Schummelia* (Fig. 96) and *T. (Trichotipula) stonei* (Fig. 126).

The abdomen often has cuticular outgrowths that are useful for differentiating certain groups. In *Arctotipula,* abdominal segments II-VII each possess two pairs of lateral tubercles and one ventral tubercle, all of a similar conical shape (Figs. 15, 16). *Nippotipula* has one or two pairs of elongate tubercles on abdominal segment VIII and two pairs of prominent outgrowths, which I call accessory lobes, anterior to the normal six spiracular lobes (Figs. 60, 62). One species of *Savtshenkia* (unreared) has many small tubercles on the dorsum and pleura, each with a small group of hairs at its apex (Fig. 91); possibly these function to anchor the larva among aquatic mosses in the fast-flowing streams where it is found. There is a pair of small, lateral swellings in *Schummelia* on segment VIII under the band of hairs (Fig. 99).

In the subgenera *Nippotipula* and *Sinotipula* and *T. (Yamatotipula) caloptera,* transverse cuticular swellings are found on abdominal segments II-VII (Figs. 62, 108). These might be termed "creeping welts," although the swellings in *Tipula* lack recurved hooks or spinules such as those found on creeping welts of other genera (e.g., *Limonia*). They do appear to have some type of anchoring function in *Tipula,* as all three groups live in flowing water where a cuticular swelling acting as a wedge between rocks, leaf debris or mosses might maintain the larva's position against the current.

Taxonomically, the most important part is the spiracular region. This consists of the spiracular disc (segment IX, including the two prominent spiracles and the surrounding area) and the six spiracular lobes arising from the posterior border of segment VIII. Some controversy has arisen concerning which segment bears the spiracles. For example, Teskey (1981) claimed the spiracles are on segment VIII, as did Alexander (1920) and others. I agree with the view of Byers (1961) that the spiracles are on a small segment IX, part of which is later invaginated inside (forming the "spiracular yoke") during the pupal stage.

The spiracular lobes show great variation in size, structure and sclerotization but are constant in number and general position. The lobes are paired: two dorsal lobes, two lateral lobes (although they are often slightly dorsolateral) and two ventral lobes (Figs. 1, 2). In aquatic and some semiaquatic larvae, the spiracular lobes are all similar in shape and generally in size. They close against one another and around but not against the spiracles. In terrestrial larvae, the dorsal and lateral lobes are usually similar in shape, and sometimes size, but the ventral lobes are often smaller and different in shape than the other lobes. When closed, the ventral lobes, at most, are appressed against the spiracles, not against the other lobes. In aquatic species the ventral lobes are directed ventrally or posteriorly (i.e., sclerotized region facing posteriorly or dorsally, Fig. 1), whereas the ventral lobes in terrestrial species are directed dorsally (i.e., inner sclerotized region facing nearly anteriorly, Fig. 2).

Aquatic species have a glabrous region on the posterior surface of the spiracular disc that extends to the apices of the spiracular lobes. This area may be lightly to heavily sclerotized, with virtually no darkened pattern in *Sinotipula* (Fig. 110), to a distinct pattern in *Angarotipula* (Fig. 5). Many aquatic species have a dark median line on each ventral lobe and often dark, marginal bands on every lobe (Fig. 145). Terrestrial species always have the inner surface of the ventral lobes glabrous and often patterned but without dark, median lines. The dorsal and lateral lobes vary from nearly unsclerotized in the *T. (Trichotipula) stonei* group or *Pterelachisus* (Fig. 84), to having large sclerites present but some areas unsclerotized in *Serratipula* (Fig. 100), and to sclerotization of the entire posterior surfaces, forming acute points at the apices in *Lunatipula, Vestiplex* and *Odonatisca* (Figs. 41, 72, 140). Two taxa, *Nippotipula* and *Arctotipula,* appear anomalous in that they are aquatic but have the posterior surfaces of all the lobes and the spiracular disc generally unsclerotized and covered with short hairs (Fig. 14). The aquatic

and semiaquatic species nearly always possess a border of apparently hydrophobic setae around the outer margins of all spiracular lobes. In *Angarotipula,* these hairs are long and dense (Fig. 5); in *Yamatotipula,* they are shorter (Fig. 145), and in some palearctic species of *Savtshenkia* the hairs are very short. In *Beringotipula,* the short hairs encircle only the spiracular disc but do not border the lobes (Fig. 27). The border of setae is absent in fully terrestrial larvae.

A number of functions have been attributed to the spiracular lobes, although none has been investigated in detail. The similarly-shaped lobes of aquatic species, with the well-developed border of hydrophobic setae, appear suited for closing around the spiracles and trapping an air bubble. The air bubble may serve to prevent the entrance of water into the spiracles (Theowald, 1957), or may act as a physical gill (Teskey, 1981;Pritchard, 1983). Glabrous spiracular lobes with well-developed hydrophobic setae, when opened at the water surface, can keep a larva afloat, particularly if it is a small larva in the second or third instar. Brindle (1960c) disagrees with the view that the enclosed air bubble might prevent the entrance of water into the spiracles, but suggests that in semiaquatic habitats soil would be excluded.

In terrestrial larvae, only the ventral lobes are closed against the spiracles, apparently preventing the entrance of water or soil particles into the spiracles. The heavily sclerotized dorsal and lateral lobes of *Lunatipula, Odonatisca* and others probably function in locomotion; the sclerotized, pointed apices might be thrust against soil and debris (i.e., when the lobes are slightly contracted posteriorly) and serve as a brace, allowing the larva to extend its forward region.

The unsclerotized lobes of *Arctotipula* and *Nippotipula* appear to have a quite different use according to Pritchard and Stewart (1982). They found the spiracles of these aquatic taxa to be non-functional with the spiracular lobes serving as a site for cutaneous respiration. This may also be a function for the various abdominal swellings and accessory lobes of both these taxa.

The spiracles vary in size, shape and color. Nearly all groups possess circular or slightly elliptical spiracles (Figs. 125, 136), but those in *Tipula (Trichotipula) oropezoides* are distinctly trilobed (Fig. 119). The spiracles are small and widely separated in *Arctotipula* and some others (Fig. 14), and quite large and close together in a number of groups, including *Platytipula* and *Bellardina* (Figs. 20, 76). The spiracles have a central circular area, usually dark brown or black, and an outer brown ring with many slit-like openings (aeropyles). The spiracles of *Arctotipula* and *Nippotipula* are thickened and raised slightly above the surrounding surface (Fig. 14); most other groups have spiracles which are nearly flush with the surface.

The anal segment, containing the anus, is a pale, membranous region below the spiracular lobes and disc. It is always bordered basally by a thin, brown or black line called the marginal band (Fig. 2). In one subgenus, *Vestiplex,* there is an additional band extending between the anus and the more ventral papillae (Fig. 140). The anal opening is transverse. The various lobes on this segment, called anal papillae, are taxonomically important. They vary in number, placement and size and are completely absent in a few taxa. The most usual arrangement is a pair of lateral papillae and one or two pairs of median papillae (Figs. 99, 149); sometimes the median papillae are somewhat anterior to the lateral one, not strictly medial in position (Fig. 75). The size, shape and number of the papillae are distinctly correlated with habitat. They are large, elongate and/or numerous in aquatic species (Figs. 6, 90) and reduced in size and number in semiaquatic and terrestrial species (Figs. 57, 113). Brindle (1957, 1960c) discussed the specialization of the papillae and postulated an osmoregulatory function; Pritchard (1983) cited the possibility of their use in gas exchange (hence the earlier use of the term "anal gills"). The stouter medial papillae in terrestrial species are of use in locomotion, according to Chiswell (1956); they act as a pushing structure in the forward extension of the body, similar to the function postulated for hook-like dorsal and lateral lobes.

The overall morphology of *Tipula* larvae does change considerably from the first through the fourth (final) instars, and this work is based only on the morphology of the fourth-instar larva. The first-instar larva usually lacks distinct spiracular lobes, and the sclerotization of the spiracular region is rudimentary (see Hennig 1950, Fig. 205). The first instar also has a simplified macrosetal arrangement and lacks most hairs. The anal papillae may also be reduced in number from that of later instars. Second-, third- and fourth-instar larvae have spiracular regions of similar shapes, but the sclerotized patterns may change among these instars; in addition, the abdominal hairs increase in number and complexity as the larva gets older. Therefore, second and third instars may possibly be identified successfully using characters found in this work, particularly if the distinctive taxonomic features are not hair or sclerite patterns. First-instar larvae cannot be identified using the characters employed in this work.

HISTORICAL REVIEW

Much of the early taxonomic work on larvae of *Tipula* concerned only one or two species, with inadequate descriptions or illustrations. Alexander's 1920 paper remains the most relevant of these early works, for he comparatively treated the larvae of twelve species of nearctic *Tipula* and recognized the value of using a variety of characters.

J. R. Chiswell (1956) published the first major study of larval *Tipula*. Dealing with a small, local fauna (Great Britain), he was able to rear over forty percent of the species. He published complete descriptions with clear drawings and presented a key to the specific level for the fourth (final), larval instars. This study was quickly followed by a similar paper by Theowald (1957), which overlapped with Chiswell's work in some of the species treated, but additionally considered the larvae within a subgeneric classification. Theowald was the first to place the larvae of European Tipulinae in subgenera and species groupings and to discuss relationships among subgenera, based on larval characters.

In the same time period, A. Brindle published a series of smaller papers (1957-1960) describing the larvae of British *Tipula* not described previously. Brindle (1960c) gave a key to the larvae of almost 50 British species and discussed the transition of larvae from terrestrial to aquatic habitats. Savchenko (1954, 1961, 1964) also illustrated various palearctic *Tipula* larvae; in 1966 (translated into German by Theowald and Theischinger, 1979) he constructed a phylogeny for the European tipuline groups, based in part on characters of the larvae.

THE GENUS *TIPULA* LINNAEUS

A useful diagnosis for larvae of the entire genus *Tipula* cannot be constructed, as every character varies enormously within the genus, and may be found in a similar state in other tipuline genera. Only a few genera of this subfamily can be separated from all *Tipula* on the basis of characters which do not occur somewhere within *Tipula: Nephrotoma* has distinct, thickened prothoracic welts; *Leptotarsus (Longurio)* has pinnately branched anal papillae; and *Brachypremna* shows a distinct contrast between short, thoracic hairs and long, dense abdominal hairs. Yet these genera are very similar in other characters to certain larvae of *Tipula*. For example, the mostly unsclerotized spiracular area of *Nephrotoma* is similar to that of *T. (Trichotipula) stonei;* the same area of *Leptotarsus* is similar to that of *T. (Arctotipula)* and the spiracular area of *Brachypremna* suggests that of *T. (Schummelia)* and *T. (Trichotipula) oropezoides*. The remaining tipuline genera are not easily separable from *Tipula*. The similarities between larvae of the genus *Prionocera* and those of *T. (Angarotipula)* are remarkable, and the two groups can only be separated on the basis of a minor difference in hairs. A similar case exists with the genus *Holorusia* and the subgenera *Platytipula* and *Bellardina*.

Larvae remain unknown for approximately one-fourth of the nearctic subgenera of *Tipula;* these subgenera are *Eremotipula, Eumicrotipula, Labiotipula, Lindnerina, Nesotipula, Setitipula* and *Tipulodinodes*. Nearly half of the nearctic subgenera have had the larvae of only one or two of their included species reared and associated. Therefore, it seems premature to offer subgeneric descriptions now, and instead I describe one or more species within each group, and discuss the characters of the subgenus based on all known larvae.

The following key to the subgenera of *Tipula* should be used in conjunction with the generic key by Alexander and Byers (1981). Larvae of *Tipula* will key to couplets 9 and 14 in the generic key; they can then be further separated to the subgeneric level using the key presented here. Larvae of the genera *Prionocera* and *Holorusia* cannot be reliably separated from those of *Tipula* in Alexander and Byers (1981) and are therefore included in the subgeneric key for *Tipula*. Distributions given in the key refer to the entire subgenus, not individual species or species groups. The key is designed for identifying fourth-instar larvae only.

KEY TO THE SUBGENERA OF *TIPULA* AND SIMILAR GENERA

1. Usually six to eight anal papillae (Figs. 90, 149), occasionally four (Figs. 99, 123), all papillae with distinctly narrowing apices; spi-

racular lobes with developed border of setae (exceptions: *Nippotipula, Arctotipula,* Figs. 14, 60); all spiracular lobes usually similar in size and shape (Figs. 89, 145); lateral lobes equal to or smaller than ventral lobes (Figs. 5, 68, 119); when closed, all lobes are against one another; in aquatic or semiaquatic situations 2

____ Four or fewer distinct papillae (Figs. 27, 57, 140), median and often lateral papillae reduced to broad protuberances; spiracular lobes without border of setae (exceptions: *Tipula* s. str., *Savtshenkia,* in part, Fig. 113); dorsal and lateral lobes usually not similar in size and shape to ventral lobes (Figs. 84, 136); ventral lobes close against spiracles, but not against dorsal and lateral lobes; in semiaquatic to terrestrial situations 15

2(1) Border of setae around spiracular lobes reduced or absent (Figs. 14, 60); posterior surfaces of spiracular lobes with little sclerotization and covered with short microscopic hairs (Fig. 61). 3

____ Border of setae around spiracular lobes strongly developed (Figs. 5, 145); posterior surfaces of spiracular lobes sclerotized and glabrous 4

3(2) Transverse swellings on dorsum and venter of each abdominal segment I-VII (Fig. 62); two pairs of accessory lobes in addition to usual six spiracular lobes (Fig. 60); all spiracular and accessory lobes (except dorsal) with at least bifurcate apices; spiracular lobes with reduced border of setae; eastern and central North America . . . . . *Nippotipula*

____ Conical swellings, one ventral and two lateral (Figs. 15, 16) on each abdominal segment II-VII (reduced or absent in some species); accessory lobes and border of setae absent from spiracular area (Fig. 14); spiracular lobes with simple apices; northern North America . . . . . *Arctotipula*

4(2) Abdominal segment VIII with dorsal semicircular row of macroscopic hairs and pair of broad lateral swellings (Figs. 98, 99); posterior surface of each dorsal lobe with extensive dark sclerite (Fig. 93); four, short anal papillae; widespread . . . . . *Schummelia*

____ Abdominal segment VIII without row of hairs; dorsal lobes with usually only light brown sclerites; usually six to eight anal papillae . . 5

5(4) Abdominal segment II-VII each with transverse ventral swelling, width often twice height (Fig. 108); abdominal dorsum with light and dark patches of short microscopic hairs, the lighter hairs forming a pair of pale, longitudinal, marginal lines or an "H"-shaped pattern (Fig. 111); macroscopic hairs absent; spiracles separated by more than 1.5× diameter of a spiracle (usually twice or more); spiracular lobes mostly unmarked (Fig. 110); western North America. . . . . *Sinotipula*

____ No conspicuous transverse abdominal swellings (exception: *T. (Yamatotipula) caloptera,* with swellings, length 3× height, Fig. 150); abdominal dorsum usually unpatterned or, if pattern present (Figs. 150, 151), then not as above and macroscopic hairs present; spiracles separated by less than 1.5× diameter of a spiracle; spiracular lobes usually distinctly marked (Fig. 76, 119) 6

6(5) Spiracular lobes each 2-3× as long as basal widths (Fig. 5) 7

____ Spiracular lobes each less than twice as long as width at base (Figs. 68, 145). 8

7(6) Abdomen with abundant macroscopic hairs (Fig. 8) and few microscopic hairs; northern North America . . . . . *Angarotipula*

____ Abdomen with rows of short microscopic hairs (Fig. 7), macroscopic

hairs only around bases of macrosetae; northern North America . . . . . genus *Prionocera*

8(6) Four anal papillae (Fig. 123) . . 9

____ Six or more anal papillae 10

9(8) Spiracles trilobed (Fig. 119); abdomen covered with macroscopic hairs (Fig. 124); microscopic hairs absent; widespread . . . . . . *Trichotipula,* in part *(oropezoides)*

____ Spiracles oval or circular (Fig. 145); macroscopic hairs only in isolated clusters (Fig. 147); microscopic hairs abundant and generally distributed; widespread . . . . . *Yamatotipula,* in part *(ludoviciana)*

10(8) Eight, subequal anal papillae (Fig. 90); widespread . . . . . *Savtshenkia,* in part

____ Six anal papillae 11

11(10) Microscopic and macroscopic hairs distinctly flattened (Fig. 70, 71), broad and reflective of light; setae L1-L3 vertically aligned (Fig. 67); eastern North America . . . . . *Nobilotipula*

____ All hairs cylindrical and narrow (Fig. 147); pleural seta L1 posterior to seta L2 (Figs. 19, 146), setae L1-L3 not vertically aligned (exception: some species of *Platytipula*) 12

12(11) Dorsum of abdomen primarily with long and short microscopic hairs, short hairs in rows (Fig. 147); macroscopic hairs in distinct clusters around setae D4, D5, V2 (Figs. 147, 148) and on dorsum of segment VIII (anterior to separation between dorsal and lateral lobes); often a conspicuous pattern on dorsum of abdomen formed by microscopic and (rarely) macroscopic hairs (Fig. 150, 151); posterior surface of each lateral lobe with at most a faint median line (Fig. 145), setae of spiracular lobe hair border short, setal length 1/2 or less of ventral lobe width; widespread . . . . . *Yamatotipula,* in part

____ Dorsum of abdomen primarily with macroscopic hairs, with at most indistinct clusters around setae D4 and V2 (Figs. 17, 18, 74, 79); microscopic hairs not in compact rows; no conspicuous hair patterns on abdomen; each lateral lobe usually with a dark median line, although line may be short (Figs. 20, 76); setae of spiracular lobe hair border long, setal length 3/4 or more of ventral lobe basal width. 13

13(12) Lateral and one medial pair of anal papillae curled dorsally around abdominal segment VIII (Fig. 23); abdominal setae D5 and V2 obscured by macroscopic hairs (Figs. 17, 18); each dorsal spiracular lobe sometimes with median dark line (Fig. 20) 14

____ All anal papillae directed laterad or ventrad, not dorsad (Fig. 75); setae D5 and V2 not obscured by macroscopic hair, all setae clearly visible (Figs. 74, 79); each dorsal lobe without dark median line (Fig. 76); widespread . . . . . *Platytipula*

14(13) Dorsum of abdominal segments I-VII with microscopic hairs isolated in small patches, or scattered singly among macroscopic hairs (Fig. 24); dorsum of segment VIII without microscopic hairs (Fig. 21), western and central North America. . . . . *Bellardina*

____ Dorsum of abdominal segments I-VII with microscopic hairs in rows intermingled with macroscopic hairs (Fig. 25); dorsum of segment VIII with microscopic and macroscopic hairs (Fig. 22); western North America . . . . . genus *Holorusia*

15(1) Border of short setae surrounding glabrous area of spiracular disc or lobes (Figs. 27, 113) 16

____ Border of setae absent (Fig. 41) 18

16(15) Eight equally short papillae, sometimes very reduced; macroscopic hairs not in isolated clusters or tufts near setae D6 and V1; widespread

. . . . . *Savtshenkia,* in part

_____ Four papillae, lateral pair distinct lobes, ventral pair reduced to broad protuberances (Fig. 113); macroscopic hairs in clusters or tufts near setae D6 and V1 (Figs. 31, 32, 116, 117) 17

17(16) Border of short setae only around central area of spiracular disc and not on margins of the lobes (Fig. 27); each ventral spiracular lobe with finger-like, subapical projection (Figs. 28, 29); posterior surfaces of dorsal and lateral lobes without sclerotization; clusters of macroscopic hairs on dorsum and venter of abdomen (Figs. 31, 32); widespread . . . . . *Beringotipula*

_____ Border of setae extending around margins of all spiracular lobes (Fig. 113); ventral lobes without subapical projection (Fig. 115); posterior surface of each dorsal and lateral lobe mostly sclerotized; abdomen with distinct tufts of dark macroscopic hairs (Figs. 116, 117); localized in North America . . . . . *Tipula* s. str. *(paludosa)*

18(15) A dark band separating anus from anal papillae, in addition to marginal band encircling anal area (Fig. 140); setae D5 and D6 both very short, seta D6 much shorter than D1 (Fig. 143); widespread . . . . . *Vestiplex*

_____ Marginal band only (Fig. 84); seta D6 longer than D5 (Fig. 50), nearly equal to or longer than seta D1 (exception: *Pterelachisus*). . . 19

19(18) Dorsal spiracular lobes sclerotized to apices and curved cephalad (Figs. 41, 42, 56) 20

_____ Dorsal lobes without sclerotized apices, although lobes may have extensive sclerites (Figs. 48, 84) 24

20(19) Lateral spiracular lobes completely sclerotized to apices (i.e. anterior and posterior surfaces) forming long curved hooks (Figs. 57, 72) 21

_____ Posterior surface of each lateral lobe with restricted dark sclerites (Fig. 136), anterior surface unsclerotized 22

21(20) Dorsum of eighth abdominal segment with sclerites extending anteriorly from each dorsal lobe (Figs. 56, 59); widespread . . . . . *Lunatipula,* in part *(disjuncta)*

_____ Dorsum of eighth abdominal segment without sclerites (Fig. 73). (See text discussion of *Odonatisca*); widespread and northern North America, respectively . . . . . *Lunatipula,* in part; *Odonatisca*

22(20) Each ventral lobe small, narrow basally, apex truncated, 1/2 to 2/3 of lobe with dark sclerite not extending onto central spiracular surface (Figs. 35, 138, 139); ventral lobes each with a long seta at apex; short microscopic hairs dense, with bare areas ("setal imprints") extending medioposteriorly from bases of setae D1-D3 (Figs. 39, 134) . . 23

_____ Each ventral lobe triangular in posterior aspect, wide basally, apex rounded, dark sclerite of inner surface extending onto spiracular surface (Figs. 43, 45); ventral lobes each with only very short setae at apex; short microscopic hairs not dense, without "setal imprints" (Fig. 46); widespread . . . . . *Lunatipula,* in part

23(22) Seta D4 short to long and always dark; one or two dark spots at base of each ventral lobe (Fig. 139); short microscopic hairs in coalescing rows with strongly developed "setal imprints" (Fig. 134); widespread. . . . . *Triplicitipula,* in part

_____ Seta D4 pale distally and of medium length; no spots at bases of ventral lobes (Fig. 35); short microscopic hairs in small, separated groups with weakly developed "setal imprints" (Fig. 39); western North America . . . . *Hesperotipula*

24(19) Short microscopic hairs absent (Fig. 126); anal papillae without distinct lobes (Fig. 125); lateral spiracular lobes long and narrow;

ventral lobes without appreciable sclerotization (Fig. 130); widespread . . . . . *Trichotipula,* in part *(stonei)*

_____ Short microscopic hairs abundant and in short rows (Figs. 47, 86); anal papillae reduced but lateral lobes distinctly visible (Fig. 48, 100); lateral spiracular lobes not particularly narrow or long; ventral lobes with extensive sclerites (Fig. 85, 102) 25

25(24) Macroseta D6 short, much shorter than D1 (Fig. 81); seta D5 often only represented as a basal socket; sclerotization of posterior surface of each dorsal lobe not extensive, usually only on basal 1/3 of lobe (Fig. 84); widespread . . . . . *Pterelachisus*

_____ Seta D6 long, similar in length to D1 (Fig. 103); seta D5 present; sclerotization of dorsal lobes extensive, covering basal 1/2 to 2/3 of each lobe (Figs. 48, 100). 26

26(25) Each ventral lobe small, with truncate apex in lateral aspect (Figs. 136, 138); dark sclerite of each lobe not extending onto central spiracular surface; a long seta at apex of each ventral lobe; widespread . . . . *Triplicitipula,* in part *(simplex)*

_____ Each ventral lobe triangular in posterior aspect, or with rounded apex (Figs. 44, 100); dark sclerite of each lobe extending onto spiracular surface; short setae only at apex of each ventral lobe (Figs. 49, 102) 27

27(26) Sclerites of dorsal and lateral lobes light brown (Fig. 100); inner circle of each spiracle brown; seta D4 equal in length to seta D1 (Fig. 103); California, Oregon. . . . . *Serratipula*

_____ Sclerites of dorsal and lateral lobes dark brown to black (Fig. 48); inner circle of each spiracle black; seta D4 shorter than seta D1 (Fig. 50); widespread . . . . . *Lunatipula,* in part *(morrisoni)*

SUBGENERIC ACCOUNTS

Subgenus *Angarotipula* Savchenko

Of the two nearctic species of *Angarotipula,* only the larva of *Tipula illustris* has been reared and associated with adults.

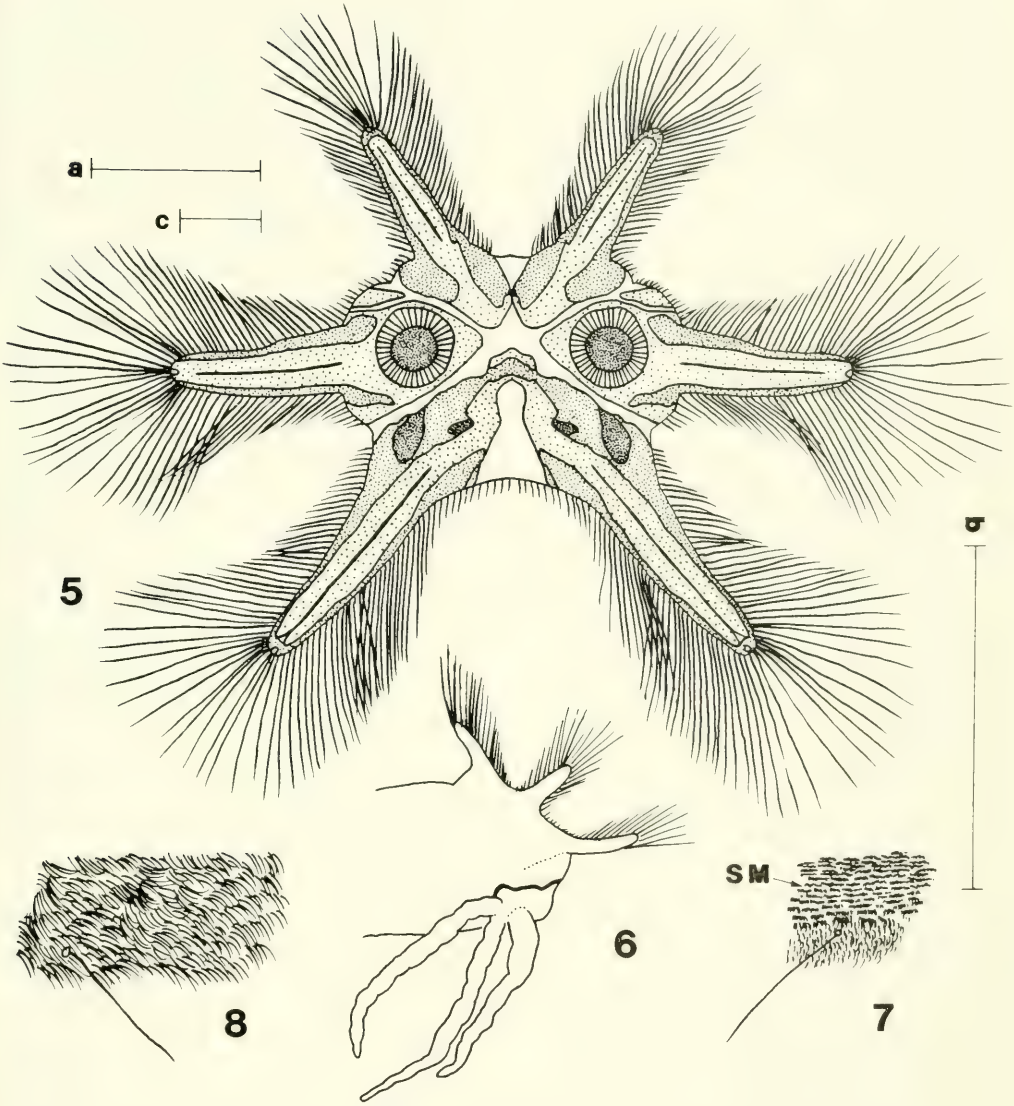
Tipula (Angarotipula) illustris Doane

Malloch 1917:199-200, figures (as *Tipula* sp. 1).
Alexander 1920:996-997, Figs. 498-502 (as *Prionocera fuscipennis*).

DESCRIPTION: Length 20.0-24.7 mm, width 2.6-3.1 mm, body yellowish brown. *Abdomen:* Macrosetae brown, setae D1-D4 long, D5 and D6 slightly shorter, D6 branched (Fig. 9). Setae L1, L2 and L4 long, L3 shorter and branched (Fig. 10). Setae V2-V4 long, V1 and V5 slightly shorter, V1 branched (Fig. 11). Macroscopic hairs abundant, densest on dorsum (Fig. 8), short microscopic hairs only along cuticular folds on venter. *Spiracular Disc:* All spiracular lobes long and narrow, each at least 3× as long as width at base, ventral lobes often 4× as long as wide, lateral lobes equidistant from dorsal and ventral lobes (Fig. 5). Lateral lobes 1.25× as long as dorsal lobes, ventral lobes approximately twice as long as dorsal lobes. Lobes with well-developed border of setae, longest setae twice basal width of lobe. Posterior surface of each lobe with median dark line extending from near base to near apex of lobe; each lobe with dark, lateral sclerites from base to apex, outer sclerites of ventral lobes extending as thin band across middle of spiracular surface. Two black spots near base of each ventral lobe. Remainder of spiracular disc yellowish. Spiracles circular, black. Marginal band light brown. *Anal Segment:* Six, subequal, elongate anal papillae (Fig. 6), lateral papillae single, medial papillae paired, length/basal width approximately 6-11.

SPECIMENS EXAMINED: Nine larvae from the following localities in ONTARIO: South March; Dunrobin; 9.7 km W of Richmond; Galt; all collected by H. Teskey (CNC).

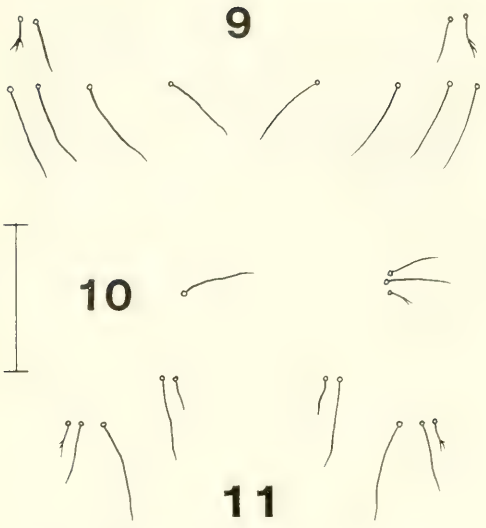
SUBGENERIC DISCUSSION: The most distinctive feature of *Angarotipula* is the long, narrow spiracular lobes, each approximately three times its basal width. Each lobe has a complete border of long setae and a dark, median line extending the length of the lobe. The sclerotized pattern on the spiracular disc is quite recognizable, particularly the dark band extending across the middle of the disc from the outer lateral areas of each ventral lobe. The body is covered by macroscopic hairs; short micro-



Figs. 5, 6, 8. *Tipula (Angarotipula) illustris.* 5, spiracular area. 6, terminal abdominal segments, lateral aspect. 8, example of abdominal macroscopic hairs. Fig. 7. *Prionocera dimidiata,* example of abdominal microscopic hairs; SM-short microscopic hairs. All scale lines 1 mm. Scale a: Fig. 5, scale b: Figs. 7, 8, scale c: Fig. 6.

scopic hairs are only along the cuticular folds.

Larvae of *Angarotipula* are more similar to those of the genus *Prionocera* than to any other larvae of *Tipula.* In fact, the two groups have proven difficult to separate as larvae, for only minor structural differences exist and they may occur in similar habitats. The most important similarities between *Angarotipula* and *Prionocera* are the long, narrow spiracular lobes, virtually identical pattern of sclerotization on the spiracular disc including a dark, median line on each lobe, a well-developed border of setae, six elongate anal papillae, and a similar arrangement of abdominal macrosetae. One feature separates the two groups: in *Angarotipula,* there is a predomi-



Figs. 9-11. *Tipula (Angarotipula) illustris,* abdominal macrosetae. 9, dorsal setae. 10, pleural setae. 11, ventral setae. Scale line 1 mm.

nance of macroscopic hairs on the abdomen, with short microscopic hairs virtually absent (Fig. 8); by contrast, the abdomen of *Prionocera* is covered with rows of short microscopic hairs with macroscopic hairs only around the bases of the dorsal and ventral macrosetae (Fig. 7).

HABITATS OF *ANGAROTIPULA:* The larval habitat of *Tipula illustris* was first described by Malloch (1917, as *Tipula* sp. no. 1) as "in an inlet among weeds at the surface." Alexander (1920, as *Prionocera fuscipennis*) collected *T. illustris* larvae in New York from a cattail swamp and also found pupal skins among *Sparganium* stems. Rogers (1942, as *Prionocera fuscipennis*) collected larvae in Michigan from "sodden, partially or wholly submerged plant detritus of the marshes and seepage areas." He found them particularly characteristic of leaf-filled or vegetation-choked channels or pools. Teskey (collection labels, CNC) found *T. illustris* larvae in Ontario in the saturated grassy soil margin of a small pool and also in a rotten log in a swamp.

G. W. Byers (collection label, KU) collected pupae of *T. parrioides* in Alaska from the margin of a pond.

Subgenus *Arctotipula* Alexander

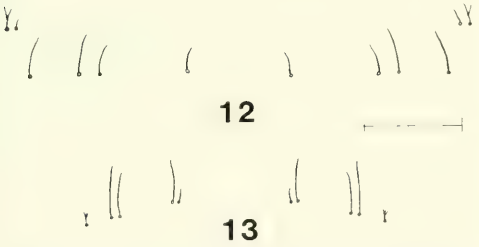
Of the 21 nearctic species of *Arctotipula,* only *Tipula sacra* is known from reared larvae associated with adults.

Tipula (Arctotipula) sacra Alexander

Pritchard and Hall 1971:474-477, Figs. 8-12, 22.

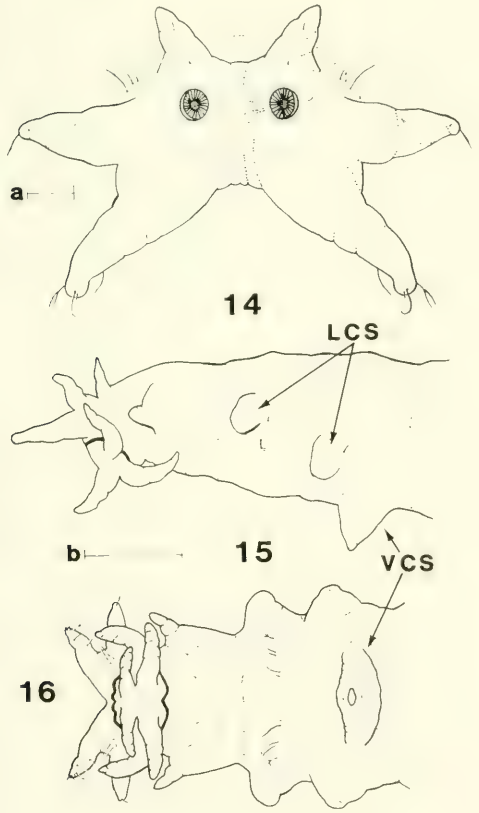
DESCRIPTION: Length 28.6-42.9 mm, width 3.9-5.1 mm, body light brown, slightly dorsoventrally depressed. *Abdomen:* Three pairs of conspicuous conical tubercles on segments II-VII, increasing in size posteriorly, largest tubercle twice as wide as long. Two pairs of tubercles on each pleural segment, one pair medioanteriorly, one pair dorsoposteriorly; third pair medioanteriorly on venter (Fig. 15). An additional pair of lateral tubercles on segment VIII, anterior to lateral spiracular lobes (Fig. 16). Macrosetae light brown. Setae D1, D5 and D6 short, D2-D4 longer, D6 usually branched (Fig. 12). Seta L1 short, L2-L4 longer, L3 usually branched. Setae V5 and V1 short, V2-V4 longer, V1 branched (Fig. 13). Short microscopic hairs covering abdomen, in transverse rows on dorsum and venter, single on pleura. An irregular pattern of lighter, circular areas sometimes visible on dorsum, pattern due to sparse microscopic hairs within the circular areas. Long microscopic and macroscopic hairs absent. *Spiracular Disc:* All spiracular lobes conical, dorsal lobe shortest, slightly longer than width at base, length of lateral lobe 1.5× length of dorsal lobe, length of ventral lobe 2.5× length of dorsal lobe (Fig. 14). Lateral lobes approximately equidistant from dorsal and ventral lobes. Lobes without darker sclerites. Spiracular disc and lobes completely covered with single short microscopic hairs except area surrounding spiracles. Macrosetae on posterior surface of all lobes; two macrosetae on dorsal lobe, near base and ⅔ lobe length; on lateral lobe, one to three at midlength, two at tip; two setae at tip of ventral lobe. Spiracles small, circular and widely separated by at least twice diameter of spiracle; inner circle dark, outer ring brown, spiracles noticeably raised from cuticular surface. Marginal band brown. *Anal Segment:* Six elongate anal papillae (Fig. 16), medial papillae paired, lateral papillae single, length/basal width 3-5.

SPECIMENS EXAMINED: Thirty-three larvae from the following localities in ALBERTA: Kananaskis Valley, Lusk Creek, H. Teskey, coll. (CNC); same locality as preceding, G. Pritchard, coll. (GP,JKG); Maycroft, H. Teskey, coll. (CNC).



Figs. 12, 13. *Tipula (Arctotipula) sacra,* abdominal macrosetae. 12, dorsal setae. 13, ventral setae. Scale line 1 mm.

SUBGENERIC DISCUSSION: Larvae of *Arctotipula,* based on *Tipula sacra* and the palearctic *T. salicetorum,* share a number of unique features. Both species possess conical, unsclerotized spiracular lobes which are almost completely covered with short microscopic hairs, and the dorsal lobes are noticeably shorter than the lateral and ventral lobes. Very striking is the absence of a developed border of setae around the spiracular lobes. Both species have small, widely separated spiracles, six long anal papillae, and the spiracular lobes may be tipped with clusters of macroscopic hairs (in *T. salicetorum*). Also notable are the presence of three pairs of cuticular swellings on abdominal segments 2-7, and an additional pair of swellings on segment 8. The body is slightly depressed, macrosetal patterns are similar in both species, short microscopic hairs predominate and there are almost no macroscopic hairs.



Figs. 14-16. *Tipula (Arctotipula) sacra.* 14, spiracular area. 15, terminal abdominal segments, lateral aspect, segments VII-X. 16, same segments as 15, ventral aspect; LCS-lateral conical swelling, VCS-ventral conical swelling. All scale lines 1 mm. Scale a: Figs. 15, 16, scale b: Fig. 14.

Certain unreared larvae, undoubtedly *Arctotipula,* have been figured previously and deserve comment here. Although possessing the basic *Arctotipula* form, these show additional variation in certain characters. Alexander (1919) described and illustrated a probable *Arctotipula* as Tipuline no. 2. This larva has the abdominal dorsum strikingly patterned with three dark longitudinal stripes. *Tipula sacra* often has a light pattern of pale circular spots on the dorsum of the abdomen. Savchenko (1961) illustrated two types of larvae as *Tipula (?Arctotipula)* sp. no. 1 and 2. Each dorsal spiracular lobe of species no. 2 has a dark, narrow median sclerite with additional dark sclerites just below the spiracles. I have seen this pattern of sclerotization on unassociated larvae collected in Alaska. In addition, these Alaskan specimens have the abdominal tubercles only as low bumps and the anal papillae are short.

Arctotipula shows many morphological similarities to *Nippotipula* and few to other subgeneric groups. The shape of the spiracular lobes, the general lack of sclerotization on the lobes, the short microscopic hairs covering the spiracular disc and the inability to close the spiracular lobes are all characters seen only in these two subgenera. The larvae of both, although aquatic, lack the well-developed border of setae around the spiracular lobes as found in other aquatic subgenera. The presence

of distinct abdominal cuticular swellings is found in *Arctotipula, Sinotipula* and *Nippotipula,* but the conical swellings in *Arctotipula* differ in position and shape from the transverse swellings of the others. The reduction of the spiracles and the almost complete lack of macroscopic hairs are also shared by these three subgenera.

HABITATS OF *ARCTOTIPULA:* The life history of *Tipula sacra* has been detailed in an excellent series of papers by Pritchard and Hall, including a general life history (Pritchard and Hall, 1971), larval food and development (Hall and Pritchard, 1975, Pritchard, 1976) and population dynamics (Pritchard 1978,1980). Pritchard and Hall found the larvae inhabiting the bottom sediments of well-oxygenated, abandoned beaver ponds. Unreared larvae of *Arctotipula* have been found in similar situations. The specimens of "Tipuline no. 2" of Alexander (1919) were collected in Alaska from "melted ponds in the tundra." I have seen other unreared larvae collected by W. L. Jellison from a pond drain in Montana and by D. G. Huggins in Alaska from the rocky bottom of a lake, near shore.

Tipula salicetorum, although not reared from the larva to the adult, has had larvae assigned to it with certainty. Hofsvang (1979) reports the larvae as inhabiting the littoral zone of a subalpine lake in southern Norway.

Subgenus *Bellardina* Edwards

The larvae of two species in this subgenus, *Tipula pura* and *T. albimacula,* have been reared during this study.

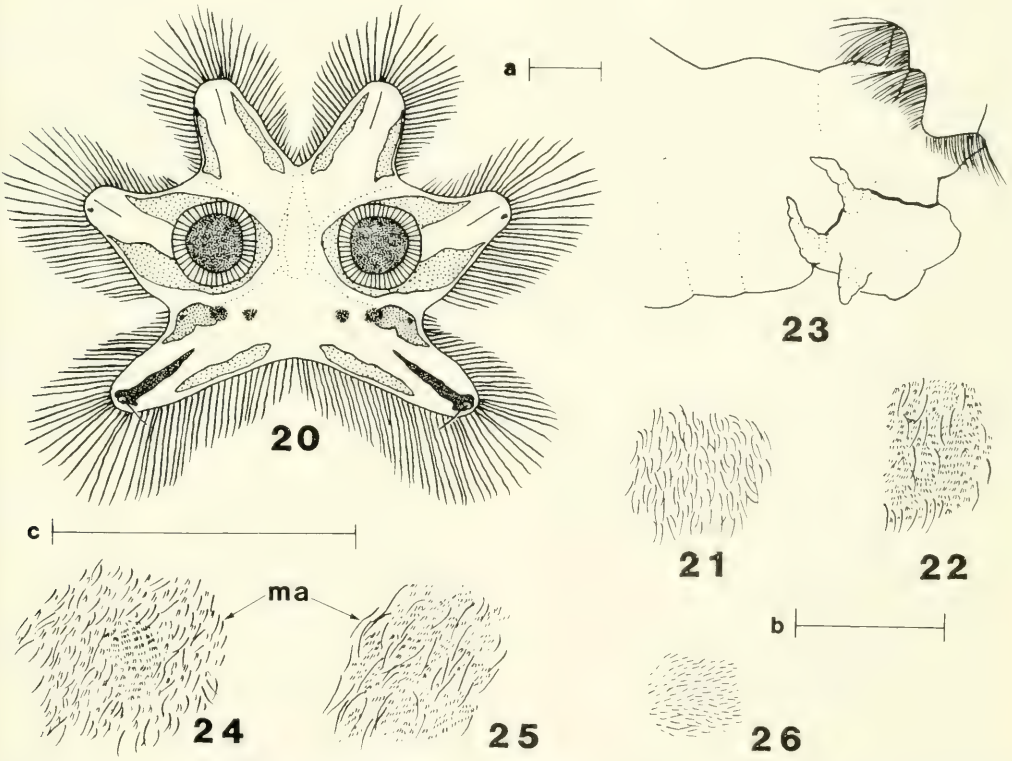
Tipula (Bellardina) pura Alexander

DESCRIPTION: Length 33.6-39.3 mm, width 4.3-5.0 mm, body light brown. *Abdomen:* Macrosetae dark brown, setae D2-D4 long, D1 and D6 shorter, D5 pale and very short, D6 branched (Fig. 17). Setae L2 and L4 long, L1 and L3 shorter, L3 branched (Fig. 19). Setae V3 long, V1, V4 and V5 shorter, V2 pale and very short, V1 often branched (Fig. 18). Scattered, single macroscopic hairs longest and more dense on dorsum of segment VIII, and around bases of setae D5 and V2 (Fig. 21); short microscopic hairs in short rows, along body folds, in paired subcircular areas on dorsum and scattered singly among macroscopic hairs (Fig. 24). Hair on pleura single (Fig. 26). *Spiracular Disc:* All lobes subequal, approximately as long as width at base, lateral lobes equidistant from dorsal and ventral lobes (Fig. 20). Lobes with a well-developed border of setae, longest setae slightly less than basal width of lobe. Posterior surface of each lobe with two light brown marginal sclerites, sclerites of lateral lobes extending around spiracles. Each ventral lobe with a dark median line, extending almost length of lobe; three dark spots at base of lobe; a long seta near apex. Dorsal and lateral lobes often with faint median line, approximately ½ length of lobe; a dark spot at apex of lateral lobe. Spiracles large, circular, inner circle dark brown, outer ring brown; distance between spiracles equal approximately to diameter of a spiracle. Remainder of spiracular disc pale. Marginal band brown. *Anal Segment:* Six anal papillae, four elongate and curled dorsad around abdomen, two short and extending ventrad (Fig. 23); length/basal width of posterior papillae 2-3, smallest papillae length/basal width 1-1.5.

SPECIMENS EXAMINED: Seventeen larvae from Gravel Pit Lakes State Recreation Area, 24.1 km W of Cimarron, on U.S. Highway 64, Colfax Co., New Mexico, J. K. Gelhaus, coll. (JKG).

SUBGENERIC DISCUSSION: *Bellardina,* to judge by *Tipula albimacula* and *T. pura,* forms a homogeneous group defined by rather generalized characters. The spiracular lobes are subequal, of medium length, and have a well-developed border of long setae. The pattern of sclerotization on the lobes is similar in both species: each ventral lobe always has a dark median line and three dark spots at the base; the dorsal and lateral lobes may also have short, faint median lines; all lobes have light brown, marginal sclerites. There are six anal papillae, four of which are elongate and curled dorsad around the abdomen. The spiracles are large, circular and not widely separated. Setae D5 and V2 are pale and difficult to see among macroscopic hairs, unlike the other, easily visible macrosetae. In fact, macroscopic hairs predominate on the body; short microscopic hairs are only restrictedly present in certain areas and are single or in short rows. Setae D6, V1 and L3 are usually branched. The larvae of both species attain a large size at maturity (30-40 mm).

Figs. 17-19. *Tipula (Bellardina) pura,* abdominal macrosetae and macroscopic hair clusters. 17, dorsal setae. 18, ventral setae. 19, pleural setae. Scale line 1 mm.



Figs. 20, 21, 23, 24, 26. *Tipula (Bellardina) pura.* 20, spiracular area. 21, example of hairs on dorsum of abdominal segment VIII. 23, terminal abdominal segments, lateral aspect. 24, example of hairs on dorsum of abdominal segments I-VII; ma-macroscopic hairs. 26, example of hairs on abdominal pleura. Figs. 22, 25. *Holorusia rubiginosa.* 22, same area as Fig. 21. 25, same area as Fig. 24. All scale lines 1 mm. Scale a: Fig. 23, scale b: Fig. 20, scale c: Figs. 21, 22, 24-26.

Many of the characters listed above are shared by other aquatic groups. For example, subequal lobes with a border of long setae, elongate anal papillae, dark median lines on the ventral lobes, abundant macroscopic hairs and branched setae are also

found in other groups such as *Yamatotipula, Platytipula,* the non-nearctic *Acutipula,* and the genus *Holorusia.* Consequently, separation of *Bellardina* from *Yamatotipula, Platytipula* and particularly *Holorusia* is rather difficult. *Yamatotipula* is distinguished by conspicuous, well-defined clusters of macroscopic hairs around setae D4, D5 and V2 and may also have conspicuous patterns of microscopic hairs; although setae D5 and V2 are obscured by macroscopic hairs in *Bellardina,* these hairs do not form distinct clusters but are simply part of the overall abundance of hairs. Additionally, short microscopic hairs are sparse and never form conspicuous patterns as seen in *Yamatotipula.*

Platytipula and *Holorusia* both have the abdomen generally covered with short microscopic hairs organized in long rows; macroscopic hairs are abundantly scattered between these rows (Figs. 22, 25). *Bellardina* has small areas of only short microscopic hairs which are not in long rows nor predominantly intermingled with macroscopic hairs (Figs. 21, 24). Other microscopic hairs are found singly among the macroscopic hairs, never in rows. The anal papillae of *Platytipula* extend laterally or ventrally and never curl upward; setae D5 and V2 are also not obscured by long hairs as in *Bellardina.* Also, the dorsal lobes may have median lines in *Bellardina* but never in *Platytipula.*

As more larvae have been associated, particularly those of *Platytipula* and *Bellardina,* the characters used in the key by Alexander and Byers (1981) for the separation of the genera *Tipula* and *Holorusia* have not proven to be useful and, consequently, have not been used in the present key.

HABITATS OF *BELLARDINA: Bellardina* occurs exclusively in the New World, with five species in North America. Four of the five are found only in the West; one other *(T. albimacula)* extends into the Central Plains.

Larvae of *T. pura* were found along the margins of a spring-fed, seepage-stream which ran for 15 m before its confluence with the Cimarron River, in New Mexico. Twenty mature larvae were found in a 30 cm square area in an exposed mud bank; additional larvae were collected in a nearby bank among roots of grasses and nettles.

Similar spring-fed aquatic habitats yielded larvae of *T. albimacula* at three localities in Kansas, all within the Flint Hills prairie region (Gelhaus, field notes). Larvae occurred in springs emanating from limestone outcroppings, specifically, among mats of watercress or aquatic mosses and apparently only from the upper areas of these springs; none were collected along the spring-fed streams.

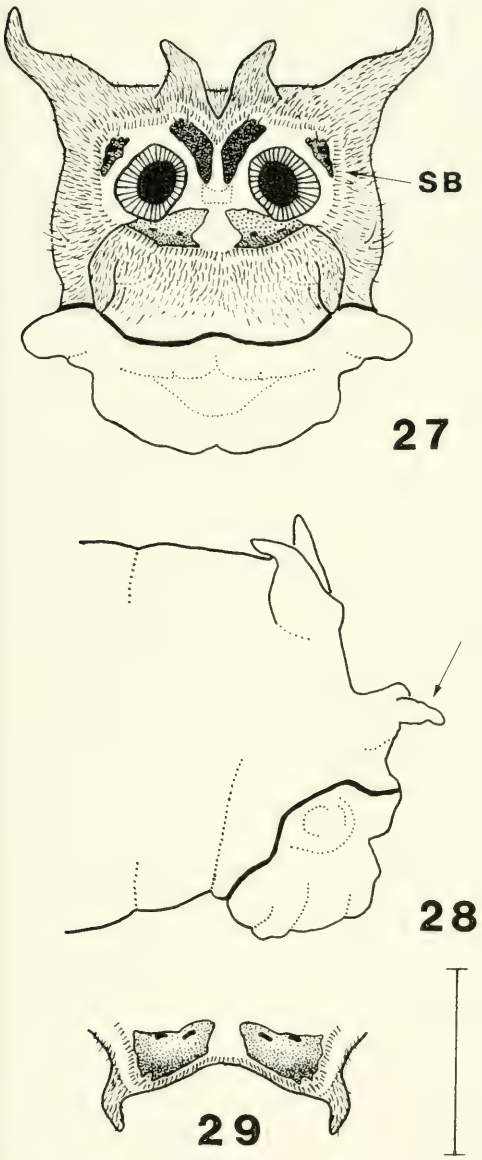
Subgenus *Beringotipula* Savchenko

I have seen larvae associated with adults for three species in this subgenus.

Tipula (Beringotipula) rohweri Doane

DESCRIPTION: Length 19.7-23.6 mm, width 2.1-2.7 mm, body light brown. *Abdomen:* Macrosetae brown, setae D2 and D3 long, D1 and D6 slightly shorter, D4 short and pale apically, D5 absent (Fig. 31). Seta L2 long, L1, L3 and L4 shorter (Fig. 30). Seta V1 long, V3-V5 slightly shorter, V2 absent (Fig. 32). Dorsum and venter with short microscopic hairs in short transverse rows, with single long microscopic hairs scattered between rows (Figs. 31, 32). Macroscopic hairs on dorsum of segments VII and VIII and in clusters near seta D6, and around D3 and D4, and V1 and V3, ventral clusters most conspicuous. Pleura with single short microscopic hairs (Fig. 30). *Spiracular Disc:* Dorsal and lateral lobes conical, lateral lobes dorsolateral, close to dorsal lobes, lateral lobes 2.0-2.5× length of dorsal lobe (Fig. 27). Lobes unsclerotized, with scattered single macroscopic hairs. A dark irregular sclerite near base of each dorsal and lateral lobe. Ventral lobes roughly triangular, as wide as long, with finger-like projection on lateral surface of lobe near apex (Fig. 28), projection approximately ½ to one length of ventral lobe (Fig. 29). Inner surface of each ventral lobe with sclerite extending to spiracle, outer edge darkest; two dark spots near inner edge. Remainder of ventral lobe with single long microscopic hairs. Border of very short setae around circumference of glabrous area of spiracular disc. Spiracles roughly oval, inner circle black, outer ring dark brown. Marginal band brown. *Anal Segment:* Four, short anal papillae (Fig. 27); each lateral papilla approximately as long as wide; each ventral papilla a broad, low swelling. Anal opening transverse.

SPECIMENS EXAMINED: Seven larvae from



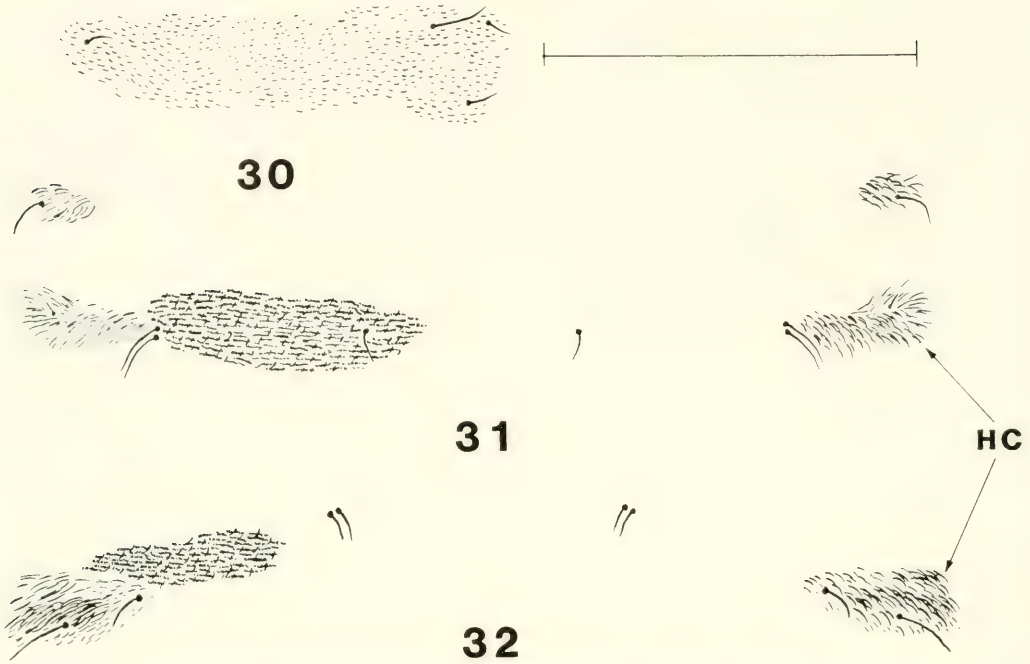
Figs. 27-29. *Tipula (Beringotipula) rohweri.* 27, spiracular area; SB-setal border. 28, terminal abdominal segments, lateral aspect. 29, ventral spiracular lobes, dorsal aspect. Scale line 1 mm.

Gravel Pit Lakes State Recreation Area, 24.1 km W of Cimarron, on U.S. Highway 64, Colfax Co., New Mexico, J. K. Gelhaus, coll. (JKG).

SUBGENERIC DISCUSSION: The larvae of *Beringotipula* form a very homogeneous group judging from the nearctic species examined, *Tipula rohweri, fallax* and *resurgens,* and the description of a palearctic species, *T. unca.* A unique feature is the digitiform projection located just below the apex of each ventral lobe. This protuberance is small (wider than long) in *T. unca* but is much longer than wide in the other known species. Wedge shaped, sclerotized spots occur near the base of each dorsal and lateral lobe but the lobes are unsclerotized and covered with single macroscopic hairs. The inner surface of each ventral lobe is sclerotized nearly to the apex and the lobes close against the spiracles. A border of short setae surrounds the glabrous area of the spiracular disc. The pattern of the darkened sclerites on the spiracular disc is similar in all the species examined. The anal papillae are short, with the lateral pair bluntly conical and the ventral papillae present only as broad protuberances. The abdomen has conspicuous, although slightly diffuse, clusters of macroscopic hairs around macrosetae V1 and V3, D3 and D4, and medial to D6. Additionally, the dorsum and venter of the abdomen has short microscopic hairs arranged in rows, with long microscopic hairs placed singly between these rows. Macroseta D4 is short and setae D5 and V2 are absent.

In the shape, size and placement of the spiracular lobes, *Beringotipula* is similar to *Pterelachisus, Savtshenkia* (cf. palearctic species *T. obsoleta* and *signata*), and the palearctic groups *Nigrotipula* and *Oreomyza.* A border of very short spiracular setae is found in the genus *Ctenophora* (cf. *C. elegans*) and the subgenera *Tipula* s. str. and *Savtshenkia* (cf. *T. signata* group sensu Theowald, 1957) as well as in *Beringotipula.* No other subgenus of *Tipula* shows a digitiform projection on each ventral lobe, but a similarity in form is found on the dorsal and lateral lobes of *Tipula* s. str. whereby each lobe is constricted distal to the sclerotized region. *Yamatotipula,* the palearctic *Acutipula* and *Beringotipula* all possess distinct macroscopic hair clusters in similar positions on the abdomen.

Beringotipula cannot be confused easily with other subgenera. The digitiform projection on each ventral lobe is unique among known tipulines, and few other taxa



Figs. 30-32. *Tipula (Beringotipula) rohweri.* 30, macrosetae and example of hairs on abdominal pleura. 31, macrosetae, hair clusters and some of the microscopic hairs, representative of abdominal dorsum I-VII; HC-hair clusters. 32, same structures as 31, ventral abdominal segments I-VII. Scale line 1 mm.

have both unsclerotized dorsal and lateral lobes and a short setal border. Although *Pterelachisus* and the palearctic *Oreomyza* and *Nigrotipula* have the spiracular disc similar to that of *Beringotipula,* they do not have the border of spiracular setae. (Correction added in proof: Theowald van Leeuwen, University of Amsterdam, informs me that a small digitiform projection on each ventral spiracular lobe is found also in larvae of the palearctic subgenus *Tipula (Mediotipula).*)

HABITATS OF *BERINGOTIPULA: Beringotipula* includes nearly 25 nearctic species whose known larvae occur in very wet habitats. Larvae of *Tipula rohweri* were collected from sodden, well-rotted logs at the edge of or lying across a small spring-fed stream in an oak-pine forest. Larvae were under the surface mosses or in the very decayed outer layers of the logs. At the same locality, other larvae of this species were found along the grassy margin of a small cold seep in the top layer of saturated soil enriched by pine needles and leaf fragments of deciduous trees.

Other species occur in similar semi-aquatic habitats. In California, I found larvae of *T. fallax* in the sandy margins of a small mountain creek, and also in mosses on a vertical limestone cliff over which water slowly trickled. In New Mexico, one larva, possibly of *T. appendiculata,* was in a leaf pack in a rapidly flowing stream.

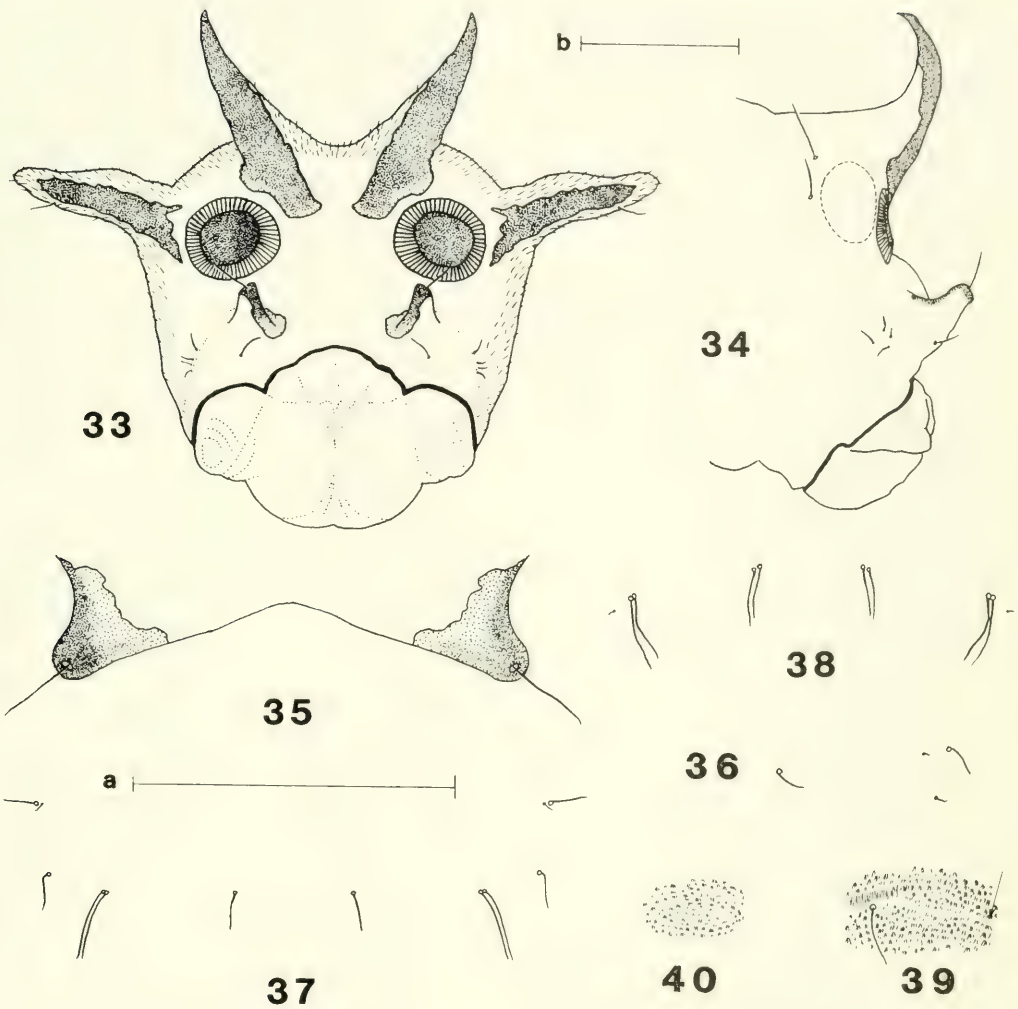
The larva of the palearctic *T. unca* has been collected from wet forest soil, often at the edges of streams and in wet moss cushions (Theowald, 1967).

Subgenus *Hesperotipula* Alexander

Of the over 20 nearctic species included in this group, the larva of only one has been reared and associated with adults.

Tipula (Hesperotipula) aitkeniana Alexander

DESCRIPTION: Length 19.2-24.3 mm, width 3.3-4.0 mm, body brownish white. *Abdomen:* All macrosetae dark brown to black, setae D2-D3 long, D1, D4 and D6 shorter, D5 very short, D4 appressed and pale distally (Fig. 37). Setae L1 and L4 long, L2 and L3 very short and appressed (Fig. 36). Setae V2-V5 long, V1 very



Figs. 33-40. *Tipula (Hesperotipula) aitkeniana.* 33, spiracular area. 34, terminal abdominal segments, lateral aspect; lateral lobe omitted. 35, ventral spiracular lobes, dorsal aspect. 36, pleural abdominal macrosetae. 37, dorsal abdominal macrosetae. 38, ventral abdominal macrosetae. 39, microscopic hairs around seta D1, showing "setal imprints". 40, example of microscopic hairs on dorsum of abdomen. All scale lines 1 mm. Scale a: Figs. 35, 39, 40, scale b: Figs. 33, 34, 36-38.

short (Fig. 38). Very short microscopic hairs in short, distinctly separated rows on dorsum and venter (Fig. 40), single on pleura. Microscopic hairs on dorsum longer around bases of macrosetae and on segment VIII; narrow areas without microscopic hairs ("setal imprints") originating from bases of D1-D3 and extending medioposteriorly for at least length of setae (Fig. 39). *Spiracular Disc:* Dorsal and lateral lobes subconical and subequal, lateral lobes dorsolateral (Fig. 33). Ventral lobes small, short, narrow basally, each with truncate apex and as wide as long (Fig. 34). Posterior surface of each dorsal lobe with extensive dark sclerite, extending from between spiracles to apex of lobe, distal one-third of lobe sclerotized anteriorly and posteriorly, apex of lobe an acute, anteriorly directed point (Fig. 34). Posterior surface of each lateral lobe with lateral sclerite, apex of lobe unsclerotized. Distal half of each ventral lobe with dark sclerite extending medially; at apex, a large seta arising from a pale spot; remainder of inner surface light brown (Fig. 35). Spiracles large, circular, outer circle

brown, inner circle black. Remainder of spiracular disc pale. Marginal band brown. *Anal Segment:* Four anal papillae, lateral papillae scarcely indicated, length ½ width or less, ventral papillae broadly rounded. Anal opening horizontal.

Specimens Examined: Eight larvae from 17.7 km E of Waterford, campground at Turlock Lake State Recreation Area, Stanislaus Co., California, J. K. Gelhaus, coll. (JKG).

Subgeneric Discussion: The heavily sclerotized dorsal lobes of *Hesperotipula,* with pointed, recurved apices, are similar to those found in the *T. (Lunatipula) fuliginosa* and *lunata* groups, *Triplicitipula* and *Vestiplex.* These groups also share other similarities, including a large amount of sclerotization on each lateral lobe (but with unsclerotized apex), reduced anal papillae and generally short, dark macrosetae in a similar arrangement. One exception to the overall similarity of macrosetae is found in seta D4, which is pale-tipped and appressed in *Hesperotipula* but is approximately the same size and in the same position as the completely dark D4 found in the other three groups. Additional relationships are seen between *Hesperotipula* and *Triplicitipula,* for both subgenera possess ventral lobes with truncated apices and similar patterns of sclerotization, and with "setal imprint" patterns in the arrangement of the microscopic hairs.

The distinctions between *Vestiplex* and *Hesperotipula* are straightforward and easily observed. *Vestiplex* possesses an added band between the anus and the anal papillae in addition to the marginal band around the anal segment and has, at most, only small sclerotized apical points on the dorsal lobes. *Hesperotipula* possesses only the marginal band and has well-developed curved points on the dorsal lobes. The separation of *Hesperotipula* from most species of *Lunatipula* is more difficult. The *T. (Lunatipula) fuliginosa* group differs from *Hesperotipula* primarily in the shape and sclerotization of the ventral lobes. In *Lunatipula,* these lobes are rounded at the apices, with some basal sclerotization, and lack the long seta at the apex of each.

Hesperotipula and *Triplicitipula* are not clearly distinguishable, and with only one species of *Hesperotipula* reared it is difficult to determine those characters most useful in the future for separating these groups. *Hesperotipula* does not have a dark spot at the base of the ventral lobe as do known species of *Triplicitipula.* The short microscopic hairs are arranged in short, distinctly separated rows, so that the overall effect in *Hesperotipula* is of sparser microscopic hairs than those found in *Triplicitipula.* This is reflected in the vague "setal imprints" of *Hesperotipula,* as the visibility of this feature is directly dependent on the density of the microscopic hairs. Seta D4 may also prove useful in separation of the two groups. This seta is pale-tipped and appressed in *Hesperotipula;* in *Triplicitipula,* it may be long or short but is completely dark.

Habitats of *Hesperotipula:* Twenty-one nearctic species are included in *Hesperotipula;* all are endemic to western North America, and most are found only in California. Habitat information is available for only two species.

The larvae of *T. aitkeniana* were collected at the upper end of a small ravine, on a slight slope under a few large trees, in the top 2 cm of damp, sandy soil under a 2.5 to 4.0 cm layer of fig, oak and horsechestnut leaves. I collected pupae of *T. linsdalei* in California from rocky soil under a deep layer of leaves, on a small hillside with alder and oak trees.

Subgenus *Lunatipula* Edwards

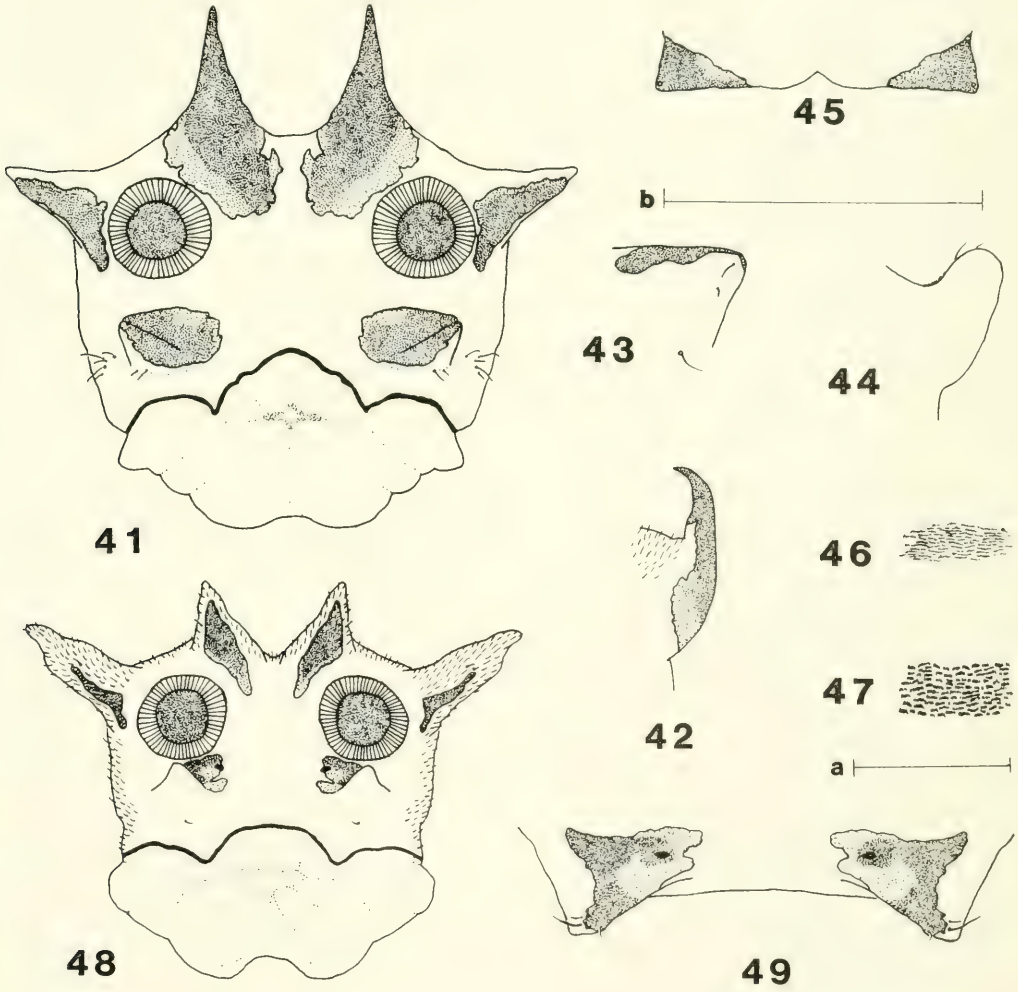
I have examined larvae reared and associated with adults for eight species of nearctic *Lunatipula.* Three of these species, *Tipula fuliginosa, T. morrisoni* and *T. disjuncta,* are described below to illustrate some of the variety of form found within the subgenus.

Tipula (Lunatipula) fuliginosa (Say)

Description: Length 27.2-29.0 mm, width 4.6-4.7 mm, body brownish white. *Abdomen:* All macrosetae blackish brown, setae D1-D3 and D6 long, D4 and D5 very short (Fig. 50). Setae L1 and L4 long, L2 and L3 very short and appressed (Fig. 52). Setae V2-V5 long, V1 very short (Fig. 51). Short microscopic hairs in short to long rows on dorsum and venter (Fig. 46),

single on pleura. *Spiracular Disc:* Dorsal and lateral spiracular lobes subconical, lateral lobes dorsolateral, length of lateral lobes ⅔ length of dorsal lobes (Fig. 41). Ventral lobes small, triangular in posterior aspect, each apex with curved margin, basal width of each twice its length (Fig. 43). Posterior surface of each dorsal lobe with complete dark sclerite extending from between spiracles to apex of lobe; distal half of lobe sclerotized anteriorly and posteriorly, apex of lobe an acute, anteriorly directed point (Fig. 42). Posterior surface of each lateral lobe with triangular dark sclerite, from near spiracles to near unsclerotized apex, lobe apex unsclerotized. Inner surface of each ventral lobe with complete dark sclerite, extending to outer surface (Fig. 45). Spiracles large, circular and black. Remainder of spiracular disc pale. Marginal band brown. *Anal Segment:* Four anal papillae, lateral papillae small, basal width twice length, ventral papillae broadly rounded.

SPECIMENS EXAMINED: Five larvae from Baldwin Woods, Breidenthal Reserve, 17.7 km SE of Lawrence, Douglas Co., Kansas, J. K. Gelhaus, coll. (JKG).



Figs. 41-43, 45, 46. *Tipula (Lunatipula) fuliginosa.* 41, spiracular area. 42, dorsal spiracular lobe, lateral aspect. 43, ventral spiracular lobe, lateral aspect. 45, ventral lobes, dorsal aspect. 46, example of microscopic hairs on dorsum of abdomen. Figs. 44, 47-49. *T. (L.) morrisoni.* 44, ventral spiracular lobe, lateral aspect. 47, same area as Fig. 46. 48, spiracular area. 49, ventral lobes, dorsal aspect. All scale lines 1 mm. Scale a: Figs. 41, 42, 45, 48, scale b: Figs. 43, 44, 46, 47, 49.

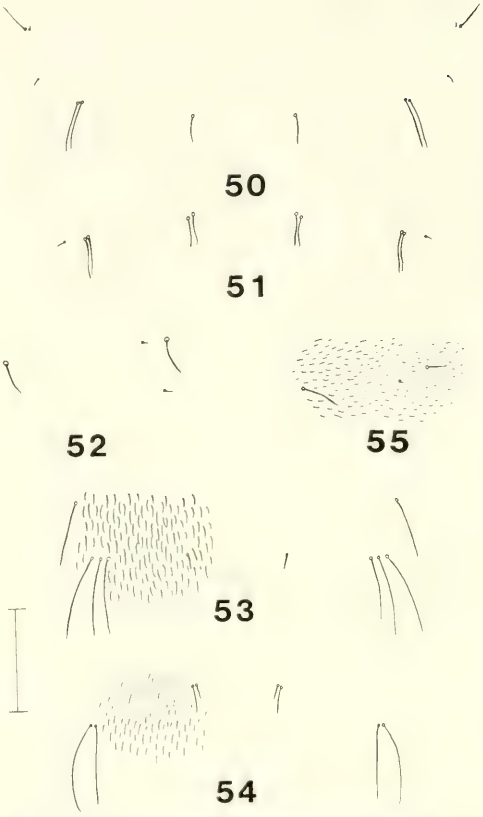
Tipula (Lunatipula) morrisoni Alexander

DESCRIPTION: Length 24.6-28.6 mm, width 3.4-4.3 mm, body gray brown. *Abdomen:* Macrosetae as in *T. fuliginosa* (Figs. 50-52). Short microscopic hairs in subequal short rows on dorsum and venter (Fig. 47), single or in small groups on pleura. *Spiracular Disc:* Dorsal and lateral spiracular lobes subconical, lateral lobes dorsolateral, length of lateral lobes twice length of dorsal lobes (Fig. 48). Ventral lobes small, triangular in posterior aspect, each with rounded apex, basal width twice length (Fig. 44). Posterior surface of each dorsal and lateral lobe with dark sclerite, on dorsal lobes extending from below base to near apex, apex of lobe unsclerotized; sclerite on lateral lobe extending from near base to midlength of lobe. Remainder of dorsal and lateral lobes with single, long microscopic hairs. Inner surface of each ventral lobe extensively sclerotized, darkest area "L"-shaped (Fig. 49). Spiracles large, circular, inner circle black, outer ring brown. Remainder of spiracular disc pale. Marginal band brown. *Anal Segment:* Four anal papillae, all broadly rounded and scarcely evident.

SPECIMENS EXAMINED: Seven larvae from the following localities in KANSAS: Douglas Co., Hole-in-the-Rock, 8.0 km W of Baldwin City, J. K. Gelhaus, coll. (JKG); Miami Co., at Miami Co. State Lake, 4.0 km E of Fontana, J. K. Gelhaus, coll. (JKG).

Tipula (Lunatipula) disjuncta Walker

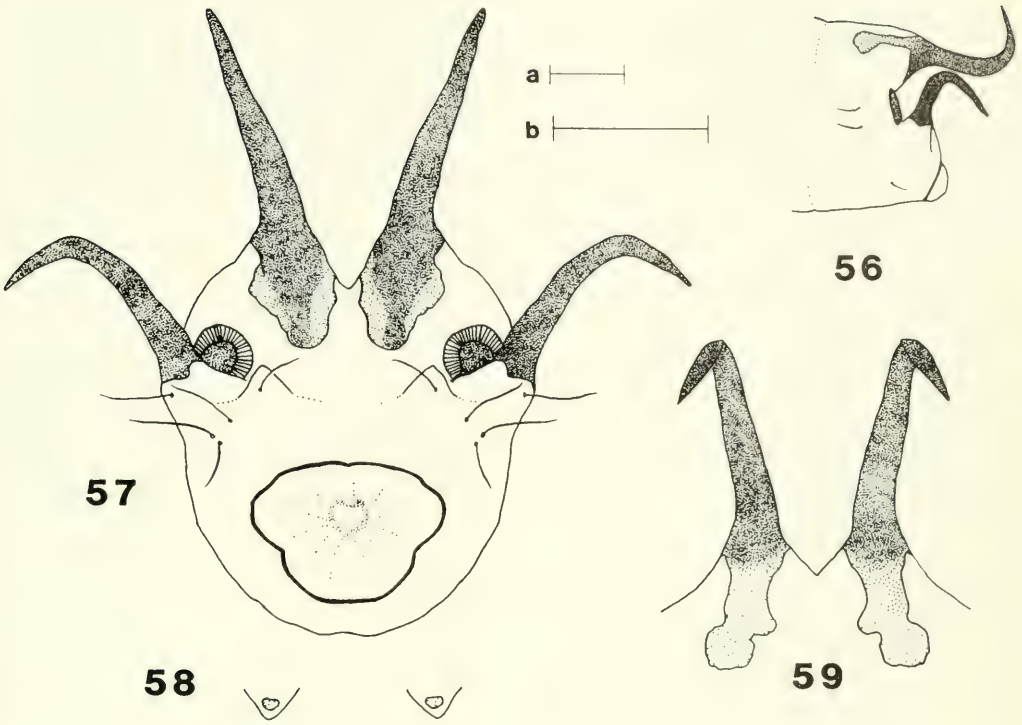
DESCRIPTION: Length 22.9 mm, width 4.3 mm, body yellowish white. *Abdomen:* All macrosetae golden-yellow setae D2-D4 and D6 very long, D1 short and inconspicuous, D5 absent (Fig. 53). Setae L4 very long, L1 short, L2 vestigial, L3 absent (Fig. 55). Setae V2 and V3 very long, V4 and V5 shorter, V1 absent (Fig. 54). Dorsum with golden-yellow macroscopic hairs, single and appressed (Fig. 53), slightly shorter on pleuron and venter (Figs. 54, 55). *Spiracular Disc:* Dorsal and lateral spiracular lobes completely sclerotized, forming smooth, curved hooks (Fig. 57), dorsal hooks longer, each dorsal lobe curved cephalad, each lateral lobe curved ventrad (Fig. 56). Sclerotization of lobes mostly reddish-brown, blackish distally. Sclerite of dorsal lobes extending basally between spiracles, anteriorly onto eighth abdominal tergite (Fig. 59). Ventral lobes small, triangular in posterior aspect, basal width of each 1.5× its length. Inner surface of each ventral lobe with pale tan, circular sclerite (Fig. 58). Spiracles small, circular, black and widely separated. Remainder of spiracular disc pale. Marginal band thin, pale brown. *Anal Segment:* Anal segment small, lobes of anal papillae indistinct.



Figs. 50-52. *Tipula (Lunatipula) fuliginosa,* abdominal macrosetae. 50, dorsal setae. 51, ventral setae. 52, pleural setae. Figs. 53-55. *T. (L.) disjuncta,* abdominal macrosetae. 53, dorsal setae and example of hairs. 54, ventral setae and example of hairs. 55, pleural setae and hairs. Scale line 1 mm.

SPECIMENS EXAMINED: One larva from University of Kansas Natural History Reservation, 8.0 km NE of Lawrence, Douglas Co. Kansas, C. W. Young, coll. (KU).

SUBGENERIC DISCUSSION: *Lunatipula* is the largest subgenus of *Tipula,* containing approximately 130 species in North America. The larvae of only ten of these species are known: three from the larval descriptions presented here, reared material for five additional species, and two from the literature *(T. usitata,* Alexander, 1920; *T. bicornis,* Forbes, 1890). The larvae of eleven palearctic species of *Lunatipula* have been described. At least three groups appear



Figs. 56-59. *Tipula (Lunatipula) disjuncta.* 56, terminal abdominal segments, lateral aspect. 57, spiracular area. 58, ventral spiracular lobes, dorsal view. 59, dorsal lobes and dorsum of abdominal segment VIII. All scale lines 1 mm. Scale a: Fig. 56, scale b: Figs. 57-59.

easily separable based on 21 species: (1) *T. bicornis, morrisoni* and the palearctic *T. vernalis,* (2) *T. disjuncta,* the palearctic *T. livida* and *lesnei,* (3) and the remainder of the reared species of *Lunatipula (T. australis, dietziana, duplex, fuliginosa, oxytona, translucida, usitata)* and the palearctic *T. lunata* group.

The most distinctive feature of all *Lunatipula* is the sclerotization of the dorsal lobes, varying from a moderate amount but with unsclerotized apices in the *T. bicornis* group, a considerable sclerotization forming short, curved apical points in *T. fuliginosa* and others, to a complete sclerotization forming long, curved hooks in the *T. disjuncta* group. The lateral lobes show a similar progression of sclerotization, from small sclerites in the *T. bicornis* group to completely sclerotized curved hooks in the *T. disjuncta* group. The ventral lobes are short, broad and triangular, with various patterns of sclerotization; pale in the *T. disjuncta* group but darker and more distinct in the remaining species of *Lunatipula.* The lateral and ventral anal papillae are distinct lobes in the palearctic *T. peliostigma* and *T. soosi,* weakly developed in *T. morrisoni* and *T. fuliginosa* and absent entirely in *T. disjuncta.*

The length and arrangement of the macrosetae are similar in the *T. bicornis* and *T. fuliginosa* groups, both groups possessing very short V1, D4 and D5 setae, and all the setae dark brown. In contrast, in the *T. disjuncta* group, the macrosetae are yellowish, noticeably elongate, and D5 and V1 are absent. Additionally, this latter group has only long, single, yellow macroscopic hairs. Both the *T. bicornis* and *T. fuliginosa* groups have a predominance of short microscopic hairs arranged in short rows.

Sclerotized, acutely pointed dorsal lobes are found to a similar degree in the *T. fuliginosa* group, *Triplicitipula, Hesperotipula* and some species of *Vestiplex.* By com-

parison, the smaller sclerites of the dorsal and lateral lobes found in the *T. bicornis* group resemble those of *Serratipula, Pterelachisus* and certain other species of *Vestiplex.* The small, triangular ventral lobes as seen in all *Lunatipula* are similar to those in *Vestiplex, Serratipula* and *Pterelachisus.* A predominance of short microscopic hairs, small but still distinct anal papillae and dark, short macrosetae are found in *Lunatipula* (excluding the *T. disjuncta* group), *Vestiplex, Serratipula,* and *Pterelachisus.*

The *T. disjuncta* group is distinct from other species groups of *Lunatipula* in many characters and shows close similarities only to the subgenus *Odonatisca;* in fact, the two groups are nearly indistinguishable. Both groups possess completely sclerotized, hook-like dorsal and lateral lobes, small ventral lobes, no distinct anal papillae, a predominance of macroscopic hairs and elongate, yellowish macrosetae. *Tipula disjuncta* and *T. livida* do have sclerotization on the eighth abdominal tergum, but at least one species in this group, *T. lesnei,* and the subgenus *Odonatisca,* lack this. It may be possible to separate these two groups using the distinctions listed in the discussion of *Odonatisca.*

Serratipula is generally similar to the *T. bicornis* group but differs in a number of features. In *Serratipula,* D4 is long, the lateral papillae are pronounced, the inner surface of each ventral lobe is almost completely sclerotized, and the spiracles are brown; moreover, most of the species occur only in California. In contrast, in the *T. bicornis* group, D4 is short, the papillae are reduced, the inner surface of each ventral lobe has a C-shaped sclerotized pattern, and the inner circle of each spiracle is black; also, none of the species in this group occur in California so far as known.

The *T. fuliginosa* group, *Triplicitipula* and *Hesperotipula* are similar in overall morphology, but the latter two subgenera possess truncated, heavily sclerotized ventral lobes and dense microscopic hairs. The *Tipula fuliginosa* group has ventral lobes with more rounded apices, and the microscopic hairs are never dense.

HABITATS OF *LUNATIPULA:* All the larvae known for this subgenus have been found in terrestrial habitats. I collected larvae of *T. fuliginosa* in Kansas from under a thick layer of leaf litter on a hilltop in an oak-hickory woods. Rogers (1942) also reared this species in Michigan from an oak-hickory woods. Alexander (1920) cited larvae of *T. fuliginosa* as "living in debris under the nest of a turkey vulture" in Maryland.

Larvae of *T. disjuncta* were collected in Kansas by C. W. Young from rich woodland soil with many pieces of rotting wood. Rogers (1942) found larvae of this species in oak-hickory woods in Michigan from "damp but friable sandy loam, just beneath the coarser leaf mold." A larva similar to *T. disjuncta,* described by Alexander (1920), as Tipulinae no. 2, was found under a rock in a field. The larvae of the palearctic species *T. livida* and *lesnei* are similar in morphology to *T. disjuncta.* Chiswell (1955) found the larvae of *T. livida* "under loose, damp moss on the floor of a beechwood" and also under moist leaf mold. Theowald (1967) additionally records *T. livida* from rotting wood. Hemmingsen (1958) collected *T. lesnei* in moist canyons, from soil 5-15 cm deep and rich in roots.

I have made two separate collections of the larvae of *T. morrisoni,* both in the upper 40 cm of soil under leaf litter in mixed deciduous woodlands. The larvae of the nearctic *T. bicornis* and the palearctic *T. vernalis,* although similar to that of *T. morrisoni* (in fact, all three are included in the same species group on the basis of adult characters), have not been found in wooded areas. Rogers (1942) wrote that the larvae of *T. bicornis* "are frequently abundant or even pests in meadows and fertile grasslands." Young (1978) collected pupae in Kansas from "grassland, about 6 mm beneath the ground surface, which was covered by a thin mat of mosses." The larva of *T. vernalis* has also been collected from grassland, occasionally as a pest in cultivated grasses, but also from borders of woodlands, the litter layer of shrubs, and once in water (Theowald, 1967; Chiswell, 1956).

Most of the other species of *Lunatipula* were reared from woodland habitats, specifically from the top layer of soil under leaf litter. Alexander (1920), however, recorded the larva of *T. usitata* from beneath the bark of a fallen tree, but it also has been reared from a "pile of dead cypress needles on roof" and from "moss found on county road" (Alexander, 1967). *Tipula oxytona,* in Florida, was found in "friable, sandy soil, usually within 50 mm of surface but as deep as 200 mm in dry seasons; larvae feed on rootlets of wire grass" (Rogers, 1933). The palearctic *T. alpina* and *T. selene* have both been reared from rotting wood and debris (Chiswell, 1956). *Tipula cava* and *T. fasciapennis* were each collected once from old cow dung (Theowald, 1967).

Subgenus *Nippotipula* Matsumura

Tipula abdominalis is the only species of this subgenus for which I have examined reared larvae associated with adults.

Tipula (Nippotipula) abdominalis (Say)

Malloch 1917:200, figures (as *Tipula* sp. 2).
Alexander 1920:1011-1013, Figs. 536-537.

Description: Length 50.1-60.1 mm, width 7.0-9.0 mm, body light brown to brownish gray. *Abdomen:* Posterior annulus of each segment I-VII with conspicuous dorsal and ventral transverse swellings (Fig. 62), dorsal swellings twice as wide as high, ventral swellings slightly higher. Segment VIII with one or two pairs of pleural tubercles (Fig. 62), each posterior tubercle slightly longer than width at base, a dark macroseta at apex; anterior tubercles shorter. Most macrosetae black. Setae D2-D4 long, D1, D5 and D6 shorter, D6 pale and branched (Fig. 63). Setae L2 and L4 long, L1 short, L3 of medium length, pale and branched, L1-L3 often on a slight swelling (Fig. 62). Setae V3 and V4 long, V5 and V1 slightly shorter, V1 pale brown, V2 absent (Fig. 64). Body with short microscopic hairs in groups of two or three (Fig. 61). *Spiracular Disc:* All spiracular lobes generally elongate and subconical, lateral lobes equidistant from dorsal and ventral lobes; dorsal lobes short, length twice width at base; lateral lobes longer, about 1.25× length of dorsal lobe; ventral lobe slightly more than 1.5× as long as of dorsal lobes (Fig. 60). Posterior surface of each dorsal lobe with a thin, vertical sclerite, darkest laterally, with border of small groups of black setae. Basal half of posterior surface of each lateral lobe with border of black setae, increasing in length distally; a thin, medial sclerite on lobe. Apex of lateral lobe bifurcated; outermost tip with dark macroseta, both tips with clusters of macroscopic hairs. Basal 0.8 of posterior surface of each ventral lobe with border of small groups of black setae, increasing in length distally; a long black seta at distal end of border. Apex of ventral lobe often bifurcated, one macroseta and macroscopic hair cluster at each apex. Remainder of spiracular disc, including all lobes, with short microscopic hairs. Two pairs of accessory lobes: one lobe anterior to area between dorsal and lateral lobes on each side, with two or three distinct tips; one lobe anterior to area between lateral and ventral lobes on each side, with three tips. Spiracles small, thick, circular and brown, widely separated by 3× or more diameter of a spiracle. Marginal band black. *Anal Segment:* Six, elongate anal papillae (Fig. 62), lateral papillae single, median papillae paired, length/basal width 3-4.

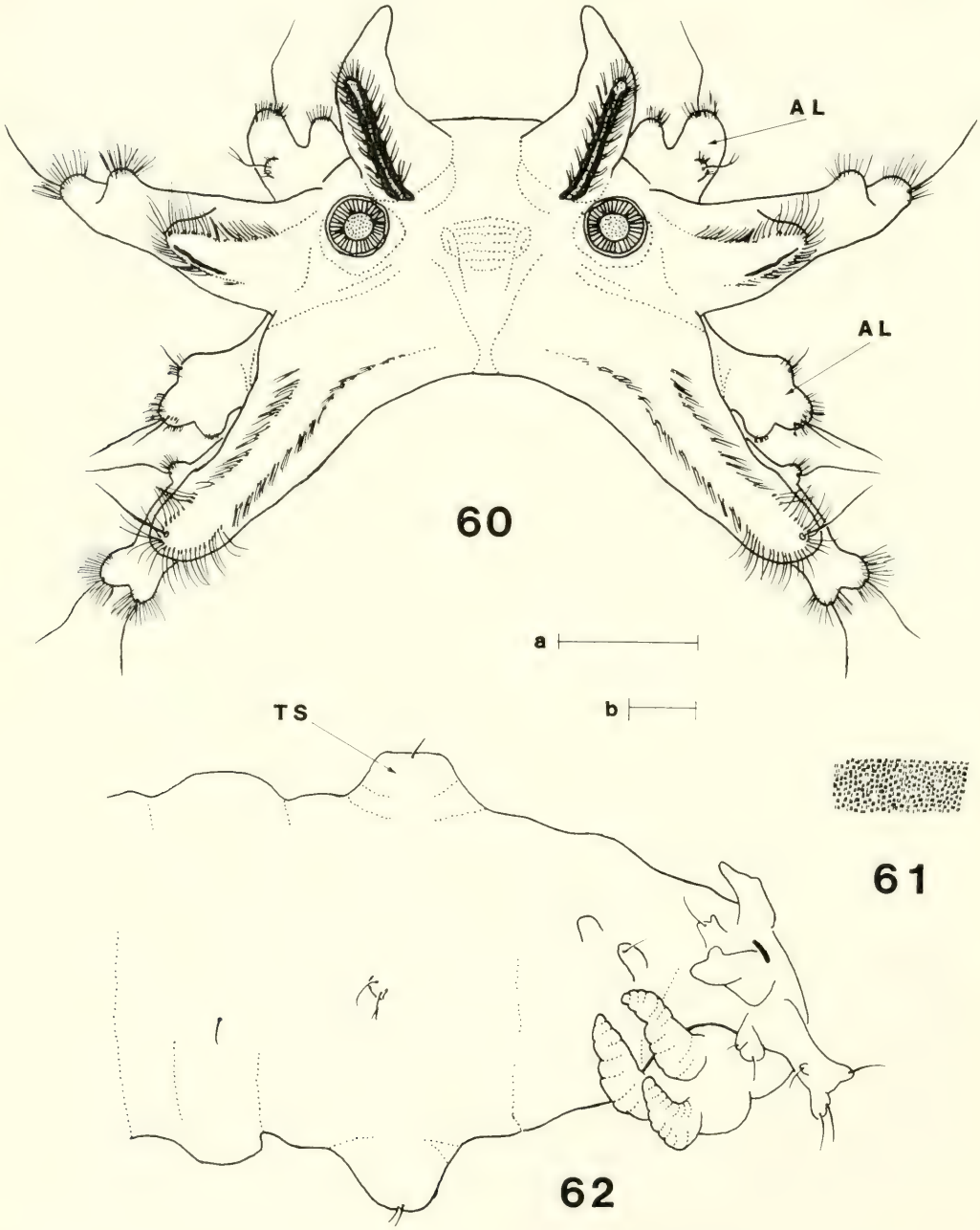
Specimens Examined: Ten larvae associated with adults from the following localities: KANSAS: Chautauqua Co., branch of Turkey Creek, 1.6 km SE of Chautauqua, J.K. Gelhaus, coll. (SBSK); Cherokee Co., unnamed spring, 4.0 km S of Galena, J.K. Gelhaus, coll. (SBSK); NEW YORK: Tompkins Co., Locke Creek, Ludlowville, H. Teskey, coll. (CNC); Tompkins Co., Cascadilla Creek, Ithaca, C.P. Alexander, coll. (UM).

Subgeneric Discussion: *Tipula abdominalis* has a distinctive spiracular disc. The spiracular lobes are subconical and almost totally unsclerotized, with the disc completely covered with short microscopic hairs. The dorsal lobes are shorter than either the lateral or ventral lobes, and none of the lobes has the ability to close over the spiracles. The accessory lobes between and anterior to the dorsal and lateral lobes and between and anterior to the lateral and ventral lobes are unique. Each of these accessory lobes has apical clusters of macroscopic hairs and one or a few macrosetae. Small, dark, narrow sclerites are found on the dorsal and lateral lobes and the setal border of the spiracular lobes is vestigial. The spiracles are small, circular, widely separated, and appear thick and slightly raised above the cuticular surface.

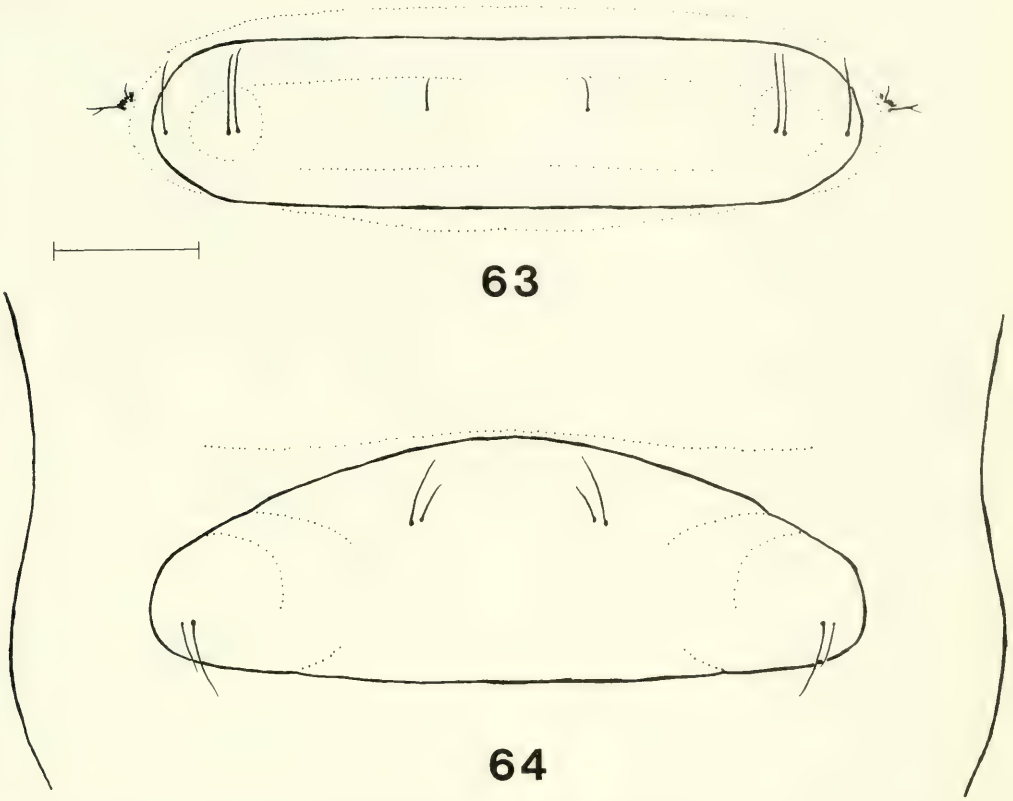
Each of the first seven abdominal segments possesses dorsal and ventral transverse swellings, and the eighth segment has

one or two pleural tubercles. Like the spiracular disc, the rest of the abdomen is covered with short microscopic hairs, but also noticeable here is the complete lack of any macroscopic hair. Seta V2 is absent and there are six, long anal papillae.

The general shape of the spiracular lobes, the overall lack of sclerotization of the spi-



Figs. 60-62. *Tipula (Nippotipula) abdominalis*. 60, spiracular area; AL-accessory lobe. 61, example of abdominal microscopic hairs. 62, terminal abdominal segments, lateral aspect; TS-transverse swelling. All scale lines 1 mm. Scale a: Figs. 60, 61, scale b: Fig. 62.



Figs. 63, 64. *Tipula (Nippotipula) abdominalis,* abdominal macrosetae. 63, dorsal setae on transverse swelling. 64, ventral setae on transverse swelling. Scale line 1 mm.

racular disc and the predominance of short microscopic hairs on it, and the inability to close the lobes over the spiracles all show similarities to the corresponding structures of *Arctotipula.* Additionally, the presence of cuticular swellings on abdominal segments I-VII, the small, widely separated spiracles and the absence of appreciable macroscopic hairs are characteristics shared by *Arctotipula, Sinotipula* and *Nippotipula.* The abdominal swellings are transverse ventrally in both *Nippotipula* and *Sinotipula* but are also found dorsally in *Nippotipula. Arctotipula* has lateral and ventral conical swellings. *Nippotipula* has only a vestigial setal border around the spiracular lobes, although a well-developed setal border is found in most other aquatic *Tipula* except for *Arctotipula.* Branching of the lateral and ventral spiracular lobes into outgrowths with apical setae and hair clusters, and the presence of accessory lobes are distinctive for *Nippotipula.* Some *Arctotipula* have apical clumps of macroscopic hair and setae on the lateral and ventral lobes, but lack the additional swellings on the spiracular lobes as well as the accessory lobes.

HABITATS OF *NIPPOTIPULA:* Only two nearctic species are included in *Nippotipula,* the well known *T. abdominalis* and the relatively recently described *T. metacomet.* Only the larva of *T. abdominalis* has been reared and associated with the adult, and the possibility exists that the larva of the sympatric *T. metacomet* has been confused with that of *T. abdominalis.*

The larvae of *T. abdominalis* are stream dwellers. Rogers (1942) collected the species in Michigan from the "leaf drift of two small sandy brooks" and in Florida (Rogers, 1933), from "among leaf drift and matted rootlets of sand bottom streams or in sand of stream bottom." Alexander (1920) found larvae "abundant under satu-

rated decaying leaves or under tussocks of grass at the edge of the water." In Kansas, I have found the larvae most abundant in rocky or gravel-bottomed streams in heavily wooded areas; they are usually in leaf packs, under rocks, or even among mats of watercress. These streams may be permanent or intermittent.

Subgenus *Nobilotipula* Alexander

Larvae of both nearctic species in this subgenus, *Tipula nobilis* and *T. collaris,* have been described. Since *T. collaris* has been previously illustrated, I will redescribe and illustrate *T. nobilis* here.

Tipula (Nobilotipula) nobilis (Loew)

Alexander 1920:1004, Fig. 507.

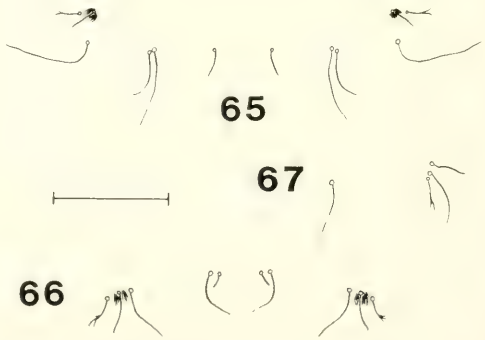
Description: Length 19.7-20.6 mm, width 2.7-3.3 mm, body yellowish brown. *Abdomen:* Most macrosetae brown, setae D2 and D4 long, D3 of medium length, D1, D5 and D6 short, D6 pale and branched (Fig. 65). Setae L2 and L4 long, L1 and L3 shorter and pale, L3 branched; L1-L3 in approximately vertical alignment (Fig. 67). Setae V3 and V4 long, V1, V2 and V5 shorter, V1 branched (Fig. 66). Microscopic hairs single, flattened, broad, scale-like and reflective (Fig. 70,71), shortest hairs appressed to body, longer hairs often perpendicular to body, hair clusters around setae D5 and V2. *Spiracular Disc:* All spiracular lobes subequal, slightly longer than width at base, lateral lobes equidistant from dorsal and ventral lobes (Fig. 68). Lobes with well-developed border of setae, longest setae approximately equal to basal width of lobe. Posterior surface of each lobe with extensive light brown sclerite. Each ventral lobe with narrowly triangular, dark, median line; two dark spots near base. Spiracles brown, inner circle with dark irregular transverse pattern. Remainder of spiracular disc pale. Marginal band light brown. *Anal Segment:* Segment large, anal opening transverse; six elongate anal papillae, anterior papillae paired, posterior papillae single (Fig. 69); lateral papillae length/basal width 5.0-5.5.

Specimens Examined: Five larvae from the following two localities: MAINE: Penobscot Co., Orono, C. P. Alexander, coll. (UM); QUEBEC: Gatineau Park, 16.1 km NW of Ottawa (Ontario), H. Teskey, coll. (CNC).

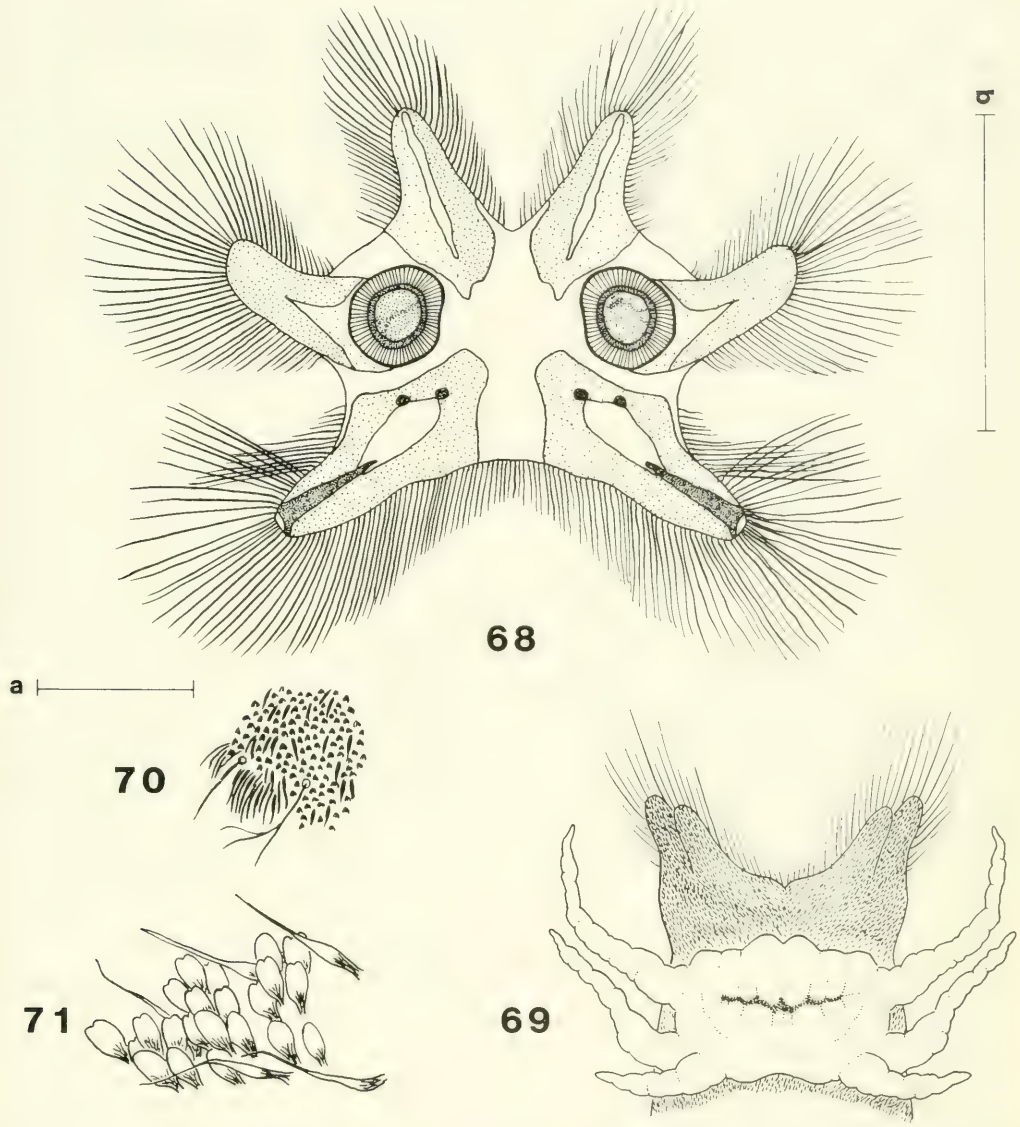
Subgeneric Discussion: The larvae of *Nobilotipula* possess two distinctive characters: the arrangement of the pleural abdominal macrosetae and the modified, lamelliform microscopic hairs. Most easily observable is the arrangement of setae L1-L3 in an approximately vertical alignment. This arrangement is also found in the palearctic *T. (Platytipula) melanoceros.* In all other known groups, and even in other species of *Platytipula* (e.g., *T. spenceriana*), seta L1 is caudad to seta L2, not above it. Although setae L1-L3 in *Angarotipula* are very close together, seta L1 is not directly dorsal to L2, but is slightly caudad to it.

The microscopic hairs in *Nobilotipula* are unique, being flattened and broad, with longitudinal ridges, and distinctly reflecting light (Fig. 71); those in other subgenera are cylindrical and narrow, without ridges, and not reflective. Two distinct lengths of microscopic hairs are seen in *Nobilotipula:* short microscopic hairs, which possess blunt, indented apices and are closely appressed to the body; and long microscopic hairs, with pointed apices that are often nearly perpendicular to the body. The hairs are usually singly placed, although in *T. collaris* the abdominal dorsum displays short rows of short microscopic hairs. These rows combine to form an overall arrangement of three pairs of circular areas anteriorly on each segment, followed by a pair of "comma"-shaped marks. In addition, the pleural microscopic hairs of this species are densely placed, giving the effect of a reddish-brown band on the abdominal pleuron.

Habitats of *Nobilotipula:* Alexander (1920) found larvae and pupae of *T. collaris*



Figs. 65-67. *Tipula (Nobilotipula) nobilis,* abdominal macrosetae. 65, dorsal setae. 66, ventral setae. 67, pleural setae. Scale line 1 mm.



Figs. 68-71. *Tipula (Nobilotipula) nobilis.* 68, spiracular area. 69, anal papillae, ventral aspect. 70, example of microscopic hairs and setae on abdomen. 71, microscopic hairs, 250×. Scale lines 1 mm. Scale a: Fig. 69, scale b: Figs. 68, 70.

beneath saturated moss (*Amblystegium irriguum* [Wils.] B. & S.) in New York. A larva and two pupae were collected by S. Hamilton and G. Schuster in North Carolina, from a small, fast-flowing, heavily shaded stream in a deciduous woodland.

Larvae of *T. nobilis* were collected by Alexander (1920) in Maine, from wet moss and also from decaying witch-hazel leaves. Additionally, H. Teskey collected larvae of *Tipula nobilis* from a woodland swamp in Quebec, and S. Teale found larvae in New York in shallow (2.5-5.0 cm deep), leaf-filled pools with a thick, organic silty bottom.

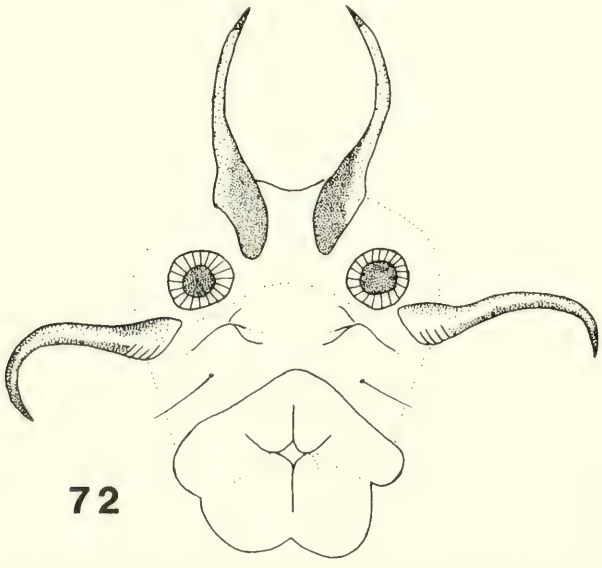
Subgenus *Odonatisca* Savchenko

Five nearctic species are included in this subgenus, three occurring in Alaska, one in the Pacific Northwest and one in southern Canada (Alexander, 1965). None of these species has been reared, but the larva of the palearctic *Tipula (Odonatisca) juncea* is known. I have not seen specimens of this species but know it from the brief descriptions of Hemmingsen (1959) and Theowald (1967).

The dorsal and lateral lobes of *T. juncea* are completely sclerotized, recurved hooks (Figs. 72, 73, redrawn from Theowald, 1967). The ventral lobes are small, triangular in posterior aspect, with the inner dorsal surface darkly sclerotized. The lateral and ventral anal papillae are greatly reduced and broadly rounded. The pattern of the abdominal macrosetae is apparently as in the *T. (Lunatipula) disjuncta* group (Figs. 53-55) except that possibly setae D1, V4 and V5 are long (Hemmingsen, 1959, Fig. 7c). The body is covered with yellowish, long microscopic hairs.

The larvae of *Odonatisca* are similar to those of certain *Lunatipula,* specifically *T. disjuncta* and the palearctic *T. livida* and *T. lesnei.* All of these possess hook-like dorsal and lateral lobes and reduced ventral lobes. The anal papillae are reduced and the macrosetal placement and length are generally alike in all these species. In fact, Theowald (1967) considers *T. juncea* and *T. lesnei* indistinguishable as larvae. Although *T. lesnei* is palearctic, it is similar to an unassociated larva from New York described by Alexander (1920, as Tipuline no. 2).

There are apparent differences between *Odonatisca* and the *T. (Lunatipula) disjuncta* group. *Tipula disjuncta* and *T. livida* have the sclerotization of the dorsal lobes extending onto the eighth abdominal tergum (Fig. 59) and a light sclerite on the inner surface of each ventral lobe (Fig. 58). There is no sclerotization on the eighth tergum in *T. lesnei* and *T. juncea* (Fig. 73), and the inner surfaces of the ventral lobes are entirely dark. Hemmingsen (1959:61) outlines a character to separate *T. lesnei* and *T. juncea.* He notes that the lateral lobes are curved downward in *T. lesnei* but the corresponding lobes of *T. juncea* are curved anteriorly (this distinction is not supported by the illustrations of Theowald, 1967, nor is it discussed in that work). Additionally, Hemmingsen shows second-instar larvae of *T. juncea* with macrosetae D1, V4 and V5 equal in length to the other setae. If this is



Figs. 72, 73. *Tipula (Odonatisca) juncea.* 72, spiracular area. 73, terminal abdominal segments, lateral aspect. Both redrawn from Theowald, 1967.

equally true for mature larvae, then this feature would also distinguish *T. juncea* from *T. lesnei.*

Added in proof: Theowald van Leeuwen, University of Amsterdam, sent two larvae of *Tipula juncea* to me for examination. The characters of these larvae agree with those stated above except for the following emendations: ventral spiracular lobes with the inner dorsal surface lightly sclerotized and two dark spots at base; macrosetae as in *Tipula disjuncta* except seta D1 is ⅔× length of setae D2-D4 and seta L3 is present and subequal in length to seta L4; lateral spiracular lobes curved somewhat anteriorly.

HABITATS OF *ODONATISCA:* Hemmingsen (1959) discussed the biology of *T. juncea* and related species. He collected larvae from an area of shifting sand in a dune forest. Theowald (1967) additionally found the larvae in dry to moderately wet forest soil.

No notes on habitats are available for any of the nearctic species, although adults of *T. (O.) pribilofensis* were collected from sand dunes in Alaska (Alexander, 1923).

Subgenus *Platytipula* Matsumura

Four nearctic species of *Platytipula* have been reared and associated with adults.

Tipula (Platytipula) spenceriana Alexander

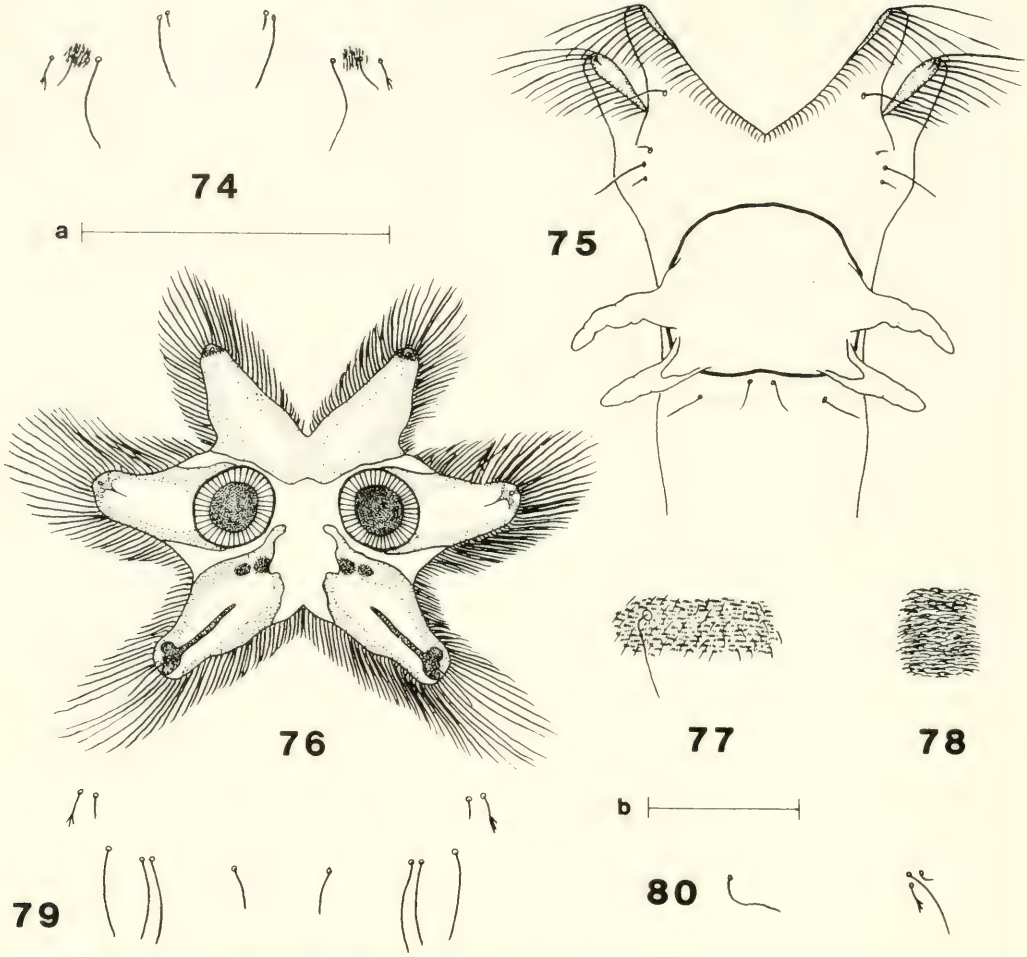
DESCRIPTION: Length 20.0-30.5 mm, width 2.3-2.6 mm, body yellow-brown. *Abdomen:* Most macrosetae dark brown, setae D2-D4 long, D1 and D6 shorter, D5 very short, D6 pale and branched (Fig. 79). Setae L2 and L4 long, L3 shorter, pale and branched, L1 very short (Fig. 80). Setae V3 and V4 long, V1 and V2 shorter, V5 very short, V1 pale and branched (Fig. 74). Very short microscopic hairs in long rows on dorsum and venter (Fig. 77), sometimes on pleura; single macroscopic hairs scattered between rows of microscopic hairs, long and most dense around bases of V2 and D2-D5. Pleura with dense, single macroscopic hairs (Fig. 78). *Spiracular Disc:* All lobes subequal, slightly longer than width at base, lateral lobes equidistant from dorsal and ventral lobes (Fig. 76). Lobes with well-developed border of setae, longest setae as long as basal width of lobes. Posterior surface of each lobe with brown sclerite, darkest at margins. Each ventral lobe with a dark, median line, approximately as long as lobe; two dark spots at base; a short, pale seta at apex. Each lateral lobe with a dark, median line, approximately ⅓ as long as lobe. Spiracles large, approximately circular, inner circle black, outer ring brown; distance between spiracles equal to diameter of a spiracle. Remainder of spiracular disc pale. Marginal band light brown. *Anal Segment:* Six anal papillae, four elongate, extending laterally or ventrally; two short; anteriormost papillae paired, posteriormost papillae single (Fig. 75); length/basal width of lateral papillae 2.5-3.5.

SPECIMENS EXAMINED: Ten larvae from Gravel Pit Lakes State Recreation Area, 24.1 km W of Cimarron, on U. S. Highway 64, Colfax Co., New Mexico, J. K. Gelhaus, coll. (JKG).

SUBGENERIC DISCUSSION: I have examined larvae of three nearctic species of *Platytipula, T. paterifera, spenceriana* and *ultima,* as well as the descriptions of *T. ultima* (Young, 1981) and *cunctans* (Hyslop, 1910, as *infuscata*). The descriptions of three palearctic species of *Platytipula* are also available (for *T. autumnalis, luteipennis* and *melanoceros*).

Larvae of *Platytipula* are all similar in structure. The spiracular lobes are all subequal and of a medium length, with a well-developed border of long setae. All species possess a long, dark median line on each ventral lobe, and usually there is a short, median line on each lateral lobe. All six lobes usually have pale brown sclerites, darkest at margin. Also, there may be two dark spots at the base of each ventral lobe (these are fused into a dark line in the palearctic *T. luteipennis*). All the species have six anal papillae of which four are long and extended laterad or ventrad. The spiracles are large and often separated by less than the diameter of a spiracle.

The size and arrangement of the macrosetae varies among the species. Setae D2 and D3 may both be short (e.g., *T. melanoceros*) or long (e.g., *T. spenceriana*) or only D2 may be long (e.g., *T. luteipennis*). Setae D5 and D6 are short in *T. melanoceros* but are longer in all other species. Seta L1 is posterodorsal to L2 in most species, but is completely dorsal to L2 in *T. melanoceros.* Setae D6, V1 and L3 are branched in at least the nearctic species examined (not shown in Theowald, 1957, 1967, or Young, 1981). The body is covered with a combi-



Figs. 74-80. *Tipula (Platytipula) spenceriana.* 74, ventral abdominal macrosetae. 75, anal papillae, ventral aspect. 76, spiracular area. 77, example of microscopic hairs on dorsum of abdomen. 78, example of microscopic hairs on pleura of abdomen. 79, dorsal abdominal macrosetae. 80, pleural abdominal macrosetae. All scale lines 1 mm. Scale a: Figs. 77, 78, scale b: Figs. 74-76, 79, 80.

nation of both short microscopic hairs and macroscopic hairs; the microscopic hairs are in long rows with single macroscopic hairs scattered between the rows. The macroscopic hairs are most dense around the bases of the macrosetae and form a weakly developed cluster of hairs around setae V2; all the setae are clearly visible, though.

Larvae of *Platytipula* are similar morphologically to those of some aquatic subgenera, and present problems in separation from certain of these. The subequal, moderately long spiracular lobes with a well-developed border of long setae, the dark median line on each ventral lobe, elongate anal papillae, branched setae and the predominance of macroscopic hairs all can be found in other aquatic subgenera, including *Yamatotipula, Bellardina, Nobilotipula,* the palearctic *Acutipula* and *Emodotipula,* and the genus *Holorusia.* In particular, larvae of *Bellardina* and the genus *Holorusia* are most difficult to distinguish from those of *Platytipula.* The geographical range, specific habitat and overall body size may help in separating the three subgenera when used in conjunction with morphological characters found in the key.

HABITATS OF *PLATYTIPULA:* *Platytipula* contains 11 species in the Nearctic and many more species in the Palearctic. There is some life history information available for five nearctic species.

Larvae of *Tipula spenceriana* were found along a small, moderately flowing, seepage-stream, which ran for only 30 m before emptying into the Cimarron River, New Mexico. When first collected in mid-May, larvae in the second and third instars were found in wet mosses and algae in the stream. Less than one month later, the stream was greatly reduced in volume and rate of flow, and the larvae were mature.

Tipula ultima may also inhabit the margins of streams. I have made a number of collections of larvae in Kansas from dense leaf debris at the edges of small, slowly flowing streams, marshy areas and seepages. The species was collected from the mud of a well-shaded seep in Kansas (Young, 1981), and in the mud surrounding crayfish burrows of a glacial pothole in Illinois (Needham, 1903, as *T. flavicans*). Caudell (1913, as *T. flavicans*) collected pupae and adults in Virginia from a wet clayey area that had been previously inundated.

Larvae of *T. cunctans* have been reported twice from water-logged meadows (Hyslop, 1910; Rogers, 1933). At both times this species occurred in huge numbers, 200 larvae per square foot (2153 per square meter) as estimated by Hyslop, and caused damage by eating the roots and shoots of pasture grasses and clover. *Tipula maritima* also was collected from a similar meadow habitat in Indiana (J. S. Rogers, field notes). I have also found larvae of *T. cunctans* in Kansas from the clay margins of a shaded, small pond and marsh. Pupae of *T. pendulifera* were found in spongy, damp soil of an open slope surrounding a montane pond in Colorado. Pupae were usually found in burrows 51-63 mm deep, under mats of mosses (G. W. Byers, field notes).

The larvae of the palearctic species inhabit similar aquatic situations, most commonly in marshy soil or Sphagnum moss (Brindle, 1959; Theowald, 1967).

Certain generalizations can be made about life histories of known *Platytipula.* In the four species I have reared, larvae are often indicative of aquatic habitats that exist primarily in winter or early spring and dry considerably or entirely during the summer. As noted by Hyslop (1910), Young (1981) and myself, larvae develop rapidly during early spring and diapause throughout the summer in an inactive state out of water, pupating in the fall.

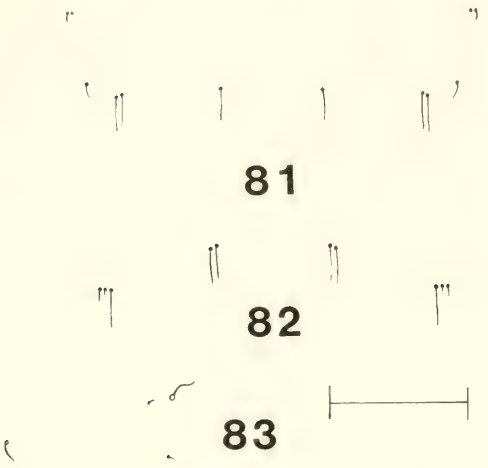
Subgenus *Pterelachisus* Rondani

Tipula (Pterelachisus) trivittata is the only nearctic species of this subgenus for which I have examined reared and associated larvae.

Tipula (Pterelachisus) trivittata Say

Greene 1909:289-290, Figs. 2-3. Alexander 1920: 1009-1010, Fig. 529. Alexander and Byers 1981: Fig. 71.

DESCRIPTION: Length 22.7-29.6 mm, width 2.7-3.6 mm, dorsum and venter light brown, pleura paler. *Abdomen:* Most macrosetae dark brown, setae D1-D3 long, D4 and D6 short, D5 pale and vestigial (Fig. 81). Setae L1 and L4 long, L2 and L3 very short, L1 dorsolateral to L2 (Fig. 83). Setae V3-V5 long, V1 and V2 short, close to V3 (Fig. 82). Short microscopic hair, in short, transverse rows of few to many hairs on dorsum and venter (Fig. 86), short microscopic hair in regularly spaced groups of one to few on pleura. *Spiracular Disc:* Dorsal and lateral lobes conical, dorsal lobes 3/4 length of lateral lobes, lateral lobes dorsolateral (Fig. 84). Dorsal and lateral lobes anteriorly with single spaced microscopic hairs, two dark macrosetae on posterior surface of each lateral lobe, 1/2 to 1/3 length from lobe tip. Dark brown, roughly triangular sclerotization on posterior surface of each dorsal lobe, from below the lobe base to 1/2 lobe length; a single seta near top of sclerotization, with pale area surrounding its base. Narrow dark brown sclerite often on posterior surface of each lateral lobe, from base to mid-length of lobe. Each ventral lobe roughly triangular in posterior aspect, with subacute tip, basal width 2.5 times length (Fig. 85). Inner surface of each ventral lobe with brown, roughly rectangular sclerite, extending from base to 2/3 length of lobe. Spiracles circular, inner circle black, outer ring brown. A small black circular area between spiracles; remainder of spiracular disc white. Marginal band brown. *Anal Segment:* Four short, rounded anal papillae (Fig. 84),



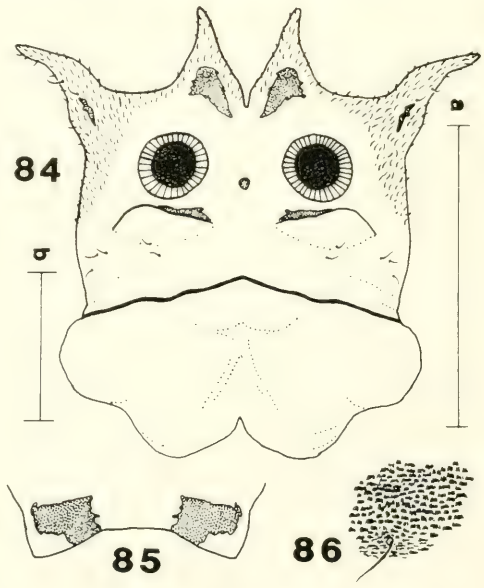
Figs. 81-83. *Tipula (Pterelachisus) trivittata,* abdominal macrosetae. 81, dorsal setae. 82, ventral setae. 83, pleural setae. Scale line 1 mm.

lateral papillae length/basal width approximately 0.50 or less.

SPECIMENS EXAMINED: Thirty-seven larvae from the following localities: ALBERTA: Kananaskis Forest, approx. 80.5 km W of Calgary, H. Teskey, coll. (CNC); KANSAS: Douglas Co., 3.2 km N of Baldwin, J. K. Gelhaus, coll. (JKG); MICHIGAN: Washtenaw Co., Ann Arbor, J. S. Rogers, coll. (UM); same as preceding, G. W. Byers, coll. (KU); NEW YORK: Tompkins Co., Ithaca, C. P. Alexander, coll. (UM); QUEBEC: Gatineau Park, 16.1 km NW of Ottawa (Ontario), H. Teskey, coll. (CNC).

SUBGENERIC DISCUSSION: *Pterelachisus,* based on *Tipula trivittata* and the descriptions of ten palearctic species, is not distinctly defined by any unique larval characters. The dorsal and lateral spiracular lobes are conical and moderately developed, becoming reduced in the palearctic *T. hortensis* and *T. interposita.* In *T. trivittata,* the sclerotization on the dorsal lobes is present only as an irregular shape near the base of the lobe; the sclerotization on each lateral lobe is a thin line or may be absent. Sclerotization of the dorsal and lateral lobes varies somewhat among the known palearctic species of *Pterelachisus.* In *T. luridirostris,* sclerotization is completely absent, while in *T. meigeni (= hortulana)* and *T. cinereocincta,* it is present as thin vertical strips, resembling the condition in some species of *Vestiplex.* The sclerotization of *T. variipennis* and *T. irrorata* approximates the condition found in *T. trivittata.* The ventral lobes in *Pterelachisus* are broad and low and usually extensively sclerotized on the inner surface. The lateral pair of anal papillae vary from a moderate development in *T. irrorata* to a complete reduction in *T. luridirostris.* Macrosetae D1-D3 and V3-V5 are long and setae D4 and D6 are short, with seta D5 apparently represented only by a socket. In *T. trivittata,* setae V1 and V2 are both short and very close to V3. In *T. irrorata* and possibly other species of *Pterelachisus,* only seta V1 is short. The body is covered with short microscopic hair, arranged in transverse rows, with macroscopic hair generally absent.

The short, conical spiracular lobes of *Pterelachisus* with the small amount of sclerotization on them can be compared to the similar situation in *Serratipula,* some species of *Vestiplex* (e.g., *T. arctica*), *Beringotipula,* and the palearctic *Oreomyza* (sensu Theowald, 1967) and *Dendrotipula.* The small and conical anal papillae, a predominance of short microscopic hairs and similar arrangements of pleural macrosetae are all



Figs. 84-86. *Tipula (Pterelachisus) trivittata.* 84, spiracular area. 85, ventral spiracular lobes, dorsal aspect. 86, example of microscopic hairs on dorsum of abdomen. All scale lines 1 mm. scale a: Fig. 86, scale b: Fig. 84, 85.

seen in *Lunatipula, Vestiplex* and *Serratipula,* as well as in *Pterelachisus.* The arrangement and size of the dorsal and ventral macrosetae are generally the same in all four groups, although in *Pterelachisus* seta D4 is short (long in *Serratipula*) and D5 is apparently absent except for a socket (present as a short seta in the other three groups).

Habitats of *Pterelachisus:* Much of what is known regarding the larval habitats for the over forty nearctic species of *Pterelachisus* pertains to one commonly collected species, *T. trivittata.* Most of the collections of larvae of *T. trivittata* are from well-rotted logs and stumps, generally under the bark or under mosses but occasionally well within the log itself. The logs used are those of deciduous trees. Three collections of *T. trivittata* larvae are of particular interest as the larvae were not found in rotting logs: in Quebec from "ground moss (dry) in oak-maple forest" by H. Teskey (collection label, CNC); in Indiana, "beneath a mixture of *Leucobryum albidum* (moss) and *Bazzania trilobata* (hepatic) on thin soil on sandstone cliff" (Rogers, field notes); in Kansas, at the bases of large oak and hickory trees on a hilltop in a heavily wooded area (Gelhaus, field notes).

Some habitat information is available for a few other nearctic species of *Pterelachisus. Tipula entomophthorae* pupae were collected in North Carolina from humus and decayed wood by G. W. Byers (collection label, KU). J. S. Rogers (1942) writes of *T. angulata,* "A pupal skin of what seems to be this species was taken from a wet aspen log. . . ."

The habitats of European *Pterelachisus* larvae may also give an idea of where the larvae of nearctic species might occur. *Tipula irrorata* larvae have been found under moss on rotten logs or inside the wood, and also in soil under mosses on boulders (Brindle, 1960c). *Tipula interposita, mitophora* and *stenostyla* also inhabit rotten wood under bark or moss (Krivosheina, 1972). *Tipula meigeni (=hortulana)* and *variipennis* have both been found in damp soil in woods (Chiswell, 1956). *Tipula cinereocincta* was collected under moss on tree trunks (Theowald, 1957). *Tipula luridirostris* was collected from the sheaths of reeds (Theowald, 1957) and from unidentified epiphytes growing on oak (Hutson and Vane-Wright, 1969). *Tipula pseudovariipennis* was found under decaying moss (Theowald, 1957).

Subgenus *Savtshenkia* Mannheims

Tipula (Savtshenkia) ignobilis is the only nearctic species of this subgenus for which I have examined reared larvae.

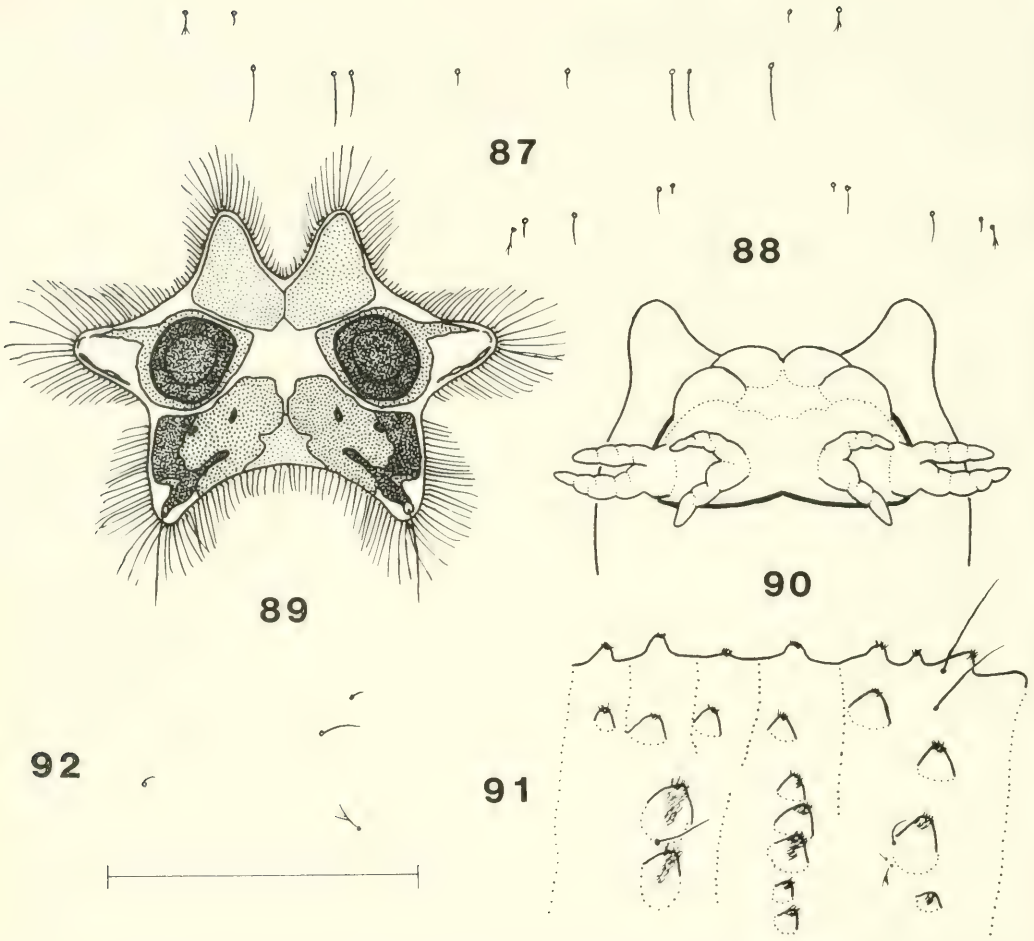
Tipula (Savtshenkia) ignobilis Loew

Alexander 1920:1010-1011, Figs. 511, 530-532.

Description: Length 11.9-17.9 mm, width 1.2-2.6 mm, body brown. *Abdomen:* Most macrosetae dark brown, setae D2-D4 long, D1 and D6 short, D6 pale and branched, D5 very short and inconspicuous (Fig. 87). Seta L2 long, L1, L3 and L4 shorter, L3 pale and branched (Fig. 92). Setae V3 and V4 long, V1 and V2 shorter, V5 very short and inconspicuous, V1 branched (Fig. 88). Abundant macroscopic hairs, densest on dorsum and venter, sparse on pleura. *Spiracular Disc:* All lobes subequal, length slightly greater than basal width, lateral lobes equidistant from dorsal and ventral lobes (Fig. 89). Lobes with well-developed border of setae, longest setae ½ basal width of lobe or less. Posterior surface of each dorsal and ventral lobe with extensive light brown sclerites, often darkest laterally, each ventral lobe also with dark, median line, and two black spots at base. Posterior surface of each lateral lobe with two narrow, lateral light brown sclerites, often extending around margin of spiracles. Spiracles brown, approximately circular; remainder of spiracular disc pale. Marginal band light brown. *Anal Segment:* Eight, subequal anal papillae of medium length, in four pairs (Fig. 90); length/basal width 2.5-4.0.

Specimens Examined: Fifteen larvae from the following localities: MICHIGAN: Washtenaw Co., Cascade Glen, 1.6 km NW of Ann Arbor, G. W. Byers, coll. (KU); NEW YORK: Tompkins Co., Ithaca, C. P. Alexander, coll. (UM); Westchester Co., Armonk, H. Knizeski, coll. (HK).

Subgeneric Discussion: Larvae are known for the nearctic species *Tipula ignobilis* and for fifteen European species. All larval *Savtshenkia* possess four pairs of subequal anal papillae. These papillae show a progression from moderately long and conical as in *T. ignobilis* and *cheethami,* to low



Figs. 87-90, 92. *Tipula (Savtshenkia) ignobilis.* 87, dorsal abdominal macrosetae; width 2 mm. 88, ventral abdominal macrosetae; width 2 mm. 89, spiracular area. 90, anal papillae, ventral aspect. 92, pleural abdominal macrosetae; width 1 mm. Fig. 91. *T. (Savtshenkia)* sp., unreared; abdominal segment, lateral aspect. Scale line 1 mm.

protuberances in *T. pagana* and *obsoleta.* The shape and placement of the spiracular lobes also varies. In *T. ignobilis,* and the *T. rufina* group (sensu Theowald, 1957), the lobes are subequal and moderately long (usually longer than wide), and radially arranged around the spiracular disc. These lobes rest against each other when closed. In other species, such as *T. obsoleta* and *marmorata,* the lobes are generally shorter with the ventral lobes closing against the spiracles, not against the dorsal and lateral lobes. All *Savtshenkia* have a border of setae around the spiracular lobes. At greatest length, in *T. ignobilis* and the *T. rufina* group, the longest setae are at least as long as half the basal width of the lobes. The border of setae is very short in species such as *T. obsoleta, odontostyla* and *marmorata,* with the longest setae less than one-fourth the basal width of the lobes. The amount of sclerotization of the spiracular lobes is also variable. In *T. ignobilis* and other species with moderately long, subequal lobes, the sclerotization is usually extensive, encompassing most of the posterior surface of each lobe. In those species with shorter lobes, the sclerotization extends onto the dorsal and lateral lobes, but only as far as their bases, with the distal areas of the lobes

remaining unsclerotized. These short lobes may be conical or low and rounded; if low, then the ventral lobes are extensively sclerotized.

The two macrosetal arrangements illustrated for the palearctic species (Theowald, 1967) differ in minor details from that of *T. ignobilis.* The *T. rufina* group apparently lacks seta D5, although this seta is found in *T. ignobilis.* In the *T. signata* group, seta D1 is ventrolateral to seta D2, while in *T. ignobilis* it is in the dorsolateral position. *Tipula ignobilis* has a moderate amount of macroscopic hairs, and this apparently is found also in at least *T. alpium* and *marmorata.* Other species, such as *Tipula cheethami,* have predominantly short microscopic hairs.

The number and form of the anal papillae provide a distinctive, synapomorphic character for a subgenus otherwise showing much diversity in larval morphology. The presence of eight, subequal anal papillae is a unique feature in the genus *Tipula,* although *Acutipula* has eight, unequal anal papillae with the two ventral pairs very short. The moderately long, well-developed, subequal spiracular lobes with a border of long setae and with all the lobes closing against one another, as found in *T. ignobilis* and the *T. rufina* group, are similar to their equivalents in the *T. (Trichotipula) oropezoides* group, *Nobilotipula,* and *Schummelia.* The *Tipula signata* group, particularly *T. marmorata* or *obsoleta,* with short spiracular lobes, a border of short setae, and the ventral lobes closing against the spiracles shows resemblance to *Beringotipula* and the palearctic *Nigrotipula* and *Mediotipula* (setal border absent). A general predominance of macroscopic hairs is also found in *T. oropezoides,* but in this species the hairs are denser.

An unreared larva which might be considered within *Savtshenkia* possesses a number of interesting features. Alexander (1920) described this larva from New York as Tipuline no. 1, and I have seen a similar larva from North Carolina. The presence of eight, subequal anal papillae would place it with *Savtshenkia.* It also has moderately long, subequal spiracular lobes with a border of long setae, but possesses many short tubercles on the abdomen, encompassing all the macrosetal bases and numerous in other areas as well (Fig. 91). In addition, most of the apices of the tubercles have clusters of macroscopic hairs. These tubercles are somewhat similar to those of the palearctic *Oreomyza* (sensu Theowald, 1967). The dorsal and lateral spiracular lobes also have a tubercle just before the apex on the anterior, unsclerotized surface. The larvae are conspicuously mottled on the dorsum with patches of dark or light short microscopic hairs, a condition found similarly in some palearctic species of *Savtshenkia,* notably *T. cheethami, simulans* and *goriziensis.*

HABITATS OF *SAVTSHENKIA:* The only habitat information available about the eleven nearctic species of *Savtshenkia* pertains to *T. ignobilis,* where larvae were collected by Alexander (1920) from wet cushions of moss *(Amblystegium)* in New York and also from wet mosses in Maine. In Kansas, Young (1978) collected larvae from "a mat of wet moss on a cliff" and J. A. Slater, Jr. collected pupae from mosses at the base of a limestone cliff where water slowly trickled. G. W. Byers reared larvae in Michigan from "mixed mosses and *Conocephalum* near a small brook. . . . Mosses shaded and on a sandy-marl bank of the brook, where much organic silt also present" (field notes).

Nearly all the palearctic species appear to be associated with mosses, although the specific conditions vary. *Tipula cheethami* has been found "among mosses and liverworts that grow at the edges of streams and on exposed stones and logs in the streams themselves" (Chiswell, 1956). *Tipula macrocera* and *T. subnodicornis* were collected in wet moorland mosses *(Hypnum, Sphagnum* and *Polytrichium)* (Brindle, 1960b), and in cold bogs of tundra and high mountains (Theowald, 1967). Cold bogs and mountain streams are the habitats of *T. goriziensis* (Theowald, 1967). Other species of *Savtshenkia* are found in drier mosses. *Tipula alpium, staegeri,* and *marmorata* are all found in mosses on walls, stones and trees (Brindle, 1960b). *Tipula pagana* is found on and under mosses on soil (Theowald, 1967).

The unreared larva discussed previously (as Tipuline no. 1, Alexander, 1920), was collected in New York from aquatic mosses *(Hypnum)* in a rapidly flowing stream.

Subgenus *Schummelia* Edwards

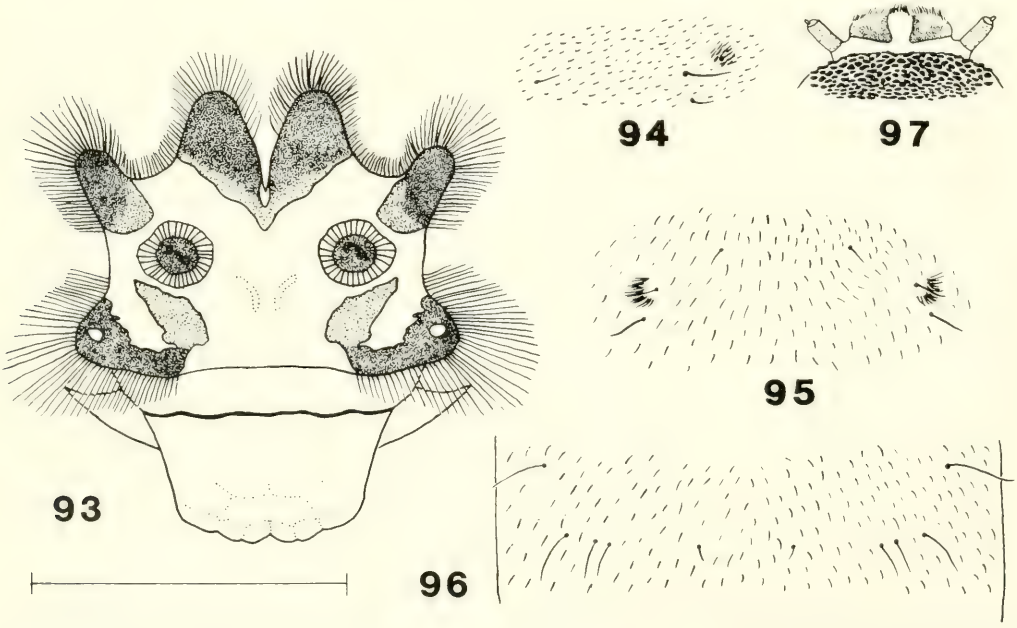
Tipula synchroa is the only nearctic species of *Schummelia* for which the larvae have been associated with adults.

Tipula (Schummelia) synchroa Alexander

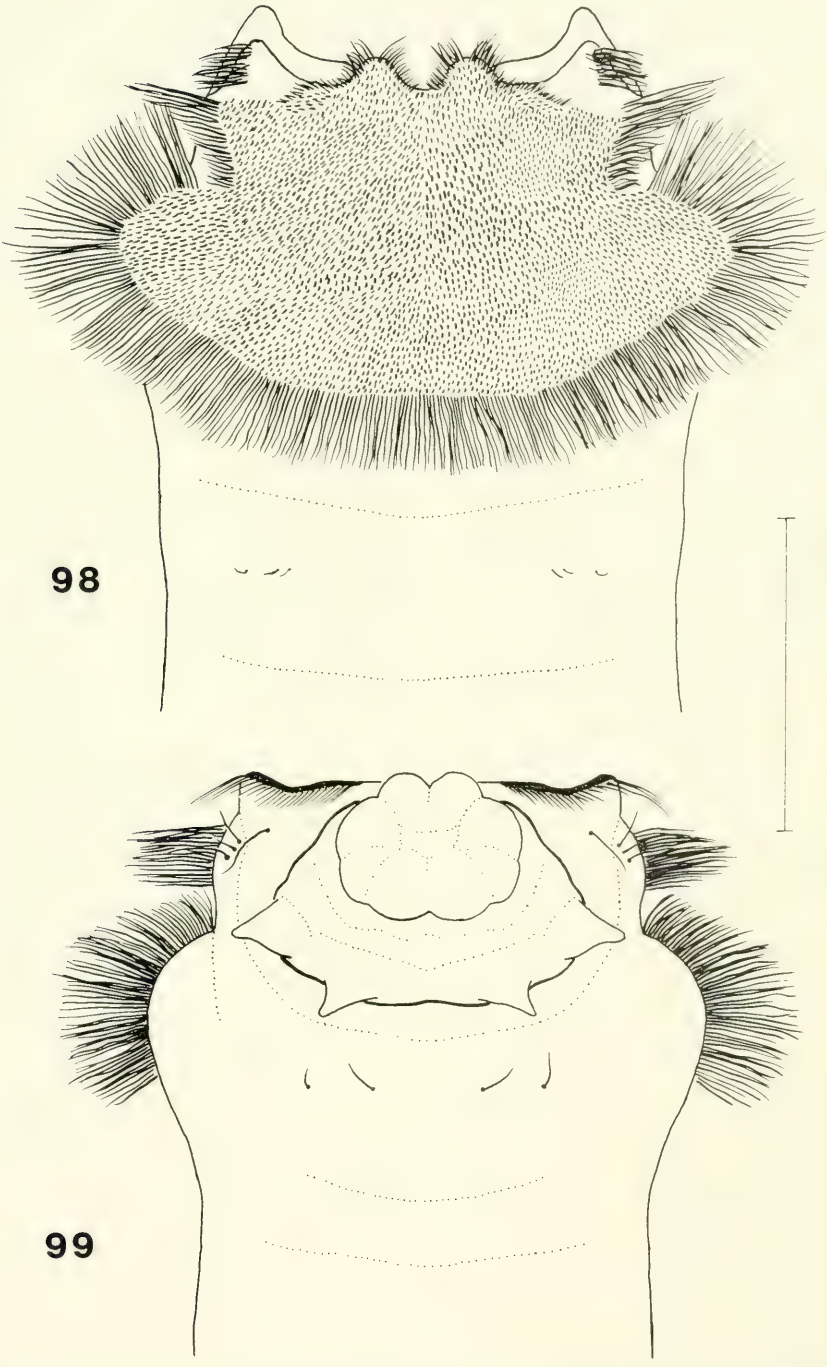
DESCRIPTION: Length 14.3-16.2 mm, width 1.4-1.6 mm, body yellowish brown. Anterior edge of prothorax with thickened cuticle (Fig. 97). *Abdomen:* Most macrosetae brown, setae D2-D4 and D6 long, D1 short, D5 absent, D6 pale (Fig. 96). Seta L2 long, L3 and L4 short, L1 very short and inconspicuous (Fig. 94). Setae V1 and V3 long, V4 short, V2 and V5 absent, V1 pale (Fig. 95). Dorsum of abdominal segment VIII with a semicircular row of long, dark brown macroscopic hairs (Fig. 98); underlying segment with pair of lateral swellings (Fig. 99), microscopic hairs between the hair row and spiracular lobes very short, stout and dark. Other microscopic hairs longer, pale and single. Small tufts of long microscopic hairs around setae L1 and V3, most conspicuous posteriorly. *Spiracular Disc:* All spiracular lobes short, dorsal and lateral lobes as long as width at base, ventral lobes slightly wider than long, lateral lobes equidistant from dorsal and ventral lobes (Fig. 93). Lobes with a well-developed border of setae, longest setae 2/3 basal width of ventral lobe. Border of setae around edges of lobes and between dorsal and lateral lobes, absent between other lobes. Posterior surface of all lobes almost completely covered with dark sclerites; dorsal lobes darkest. Ventral lobe with subapical clear spot, complete sclerite C-shaped. Anterior surface of dorsal and lateral lobes with well-developed subapical clusters of macroscopic hairs. Spiracles subcircular, inner circle dark brown, outer ring brown, distance between spiracles slightly greater than diameter of spiracle. Remainder of spiracular disc pale. Marginal band brown. *Anal Segment:* Segment protuberant; four subequal, single, conical anal papillae (Fig. 99), each as long as wide, anterior and anteriolateral to anus.

SPECIMENS EXAMINED: Nine larvae from Devil's Mill Hopper, 11.3 km NW of Gainesville, Alachua Co., Florida, J. S. Rogers, coll. (UM).

SUBGENERIC DISCUSSION: *Schummelia,* judging by *Tipula synchroa* and the palearctic *T. variicornis,* forms an extremely



Figs. 93-97. *Tipula (Schummelia) synchroa.* 93, spiracular area. 94, pleural abdominal macrosetae and microscopic hairs. 95, ventral abdominal macrosetae and microscopic hairs. 96, dorsal abdominal macrosetae and microscopic hairs. 97, anteriormost area of prothorax and head capsule, dorsal aspect. Scale line 1 mm.



Figs. 98, 99. *Tipula (Schummelia) synchroa,* terminal abdominal segments. 98, dorsal aspect. 99, ventral aspect. Scale line 1 mm.

distinct group. Both species possess the conspicuous, semicircular row of macroscopic hairs on the dorsum of the eighth abdominal segment, with the hairs longest in *T. synchroa.* Additionally, the eighth segment has a pair of protuberances beneath the lateral regions of this hair row. The spiracular lobes are all short with well-sclerotized posterior surfaces, the dorsal lobes most darkly sclerotized. In *T. synchroa,* the anterior surface of the dorsal lobes is unsclerotized and bears subapical clusters of hairs, while in *T. variicornis,* the sclerotization on the posterior surface extends onto the edges of the anterior surface. In both species, the anterior surface of each lateral lobe is covered with macroscopic hairs. The setal border of the spiracular lobes is well-developed, where it occurs, but it is interrupted between the lateral and ventral lobes. In *T. variicornis,* the border of setae is absent entirely from the dorsal lobes. The anal segment is protuberant with four short or moderately long, single papillae. Abdominal seta V2 is absent in both species and V5 and D5 are additionally absent in *T. synchroa.* There are weakly-developed clusters of long microscopic hairs between setae V1 and V3 and around L2. The short microscopic hairs are stouter and dark on the dorsum of the eighth abdominal segment anterior to the spiracular lobes, and closely spaced and appressed on the anterior edge of the prothorax; the remainder of the body is covered with pale microscopic hairs.

The shape, size, placement and sclerotization of the spiracular lobes in *Schummelia,* show a similarity to their equivalents in the *T. (Trichotipula) oropezoides* group. The four, single anal papillae and their placement are also similar to *Trichotipula.* Other subgenera possess four papillae but have the medial pair reduced to rounded, not elongated lobes. Clusters or tufts of hairs can be found in *Beringotipula, Tipula* s. str. and *Yamatotipula* as well as in *Schummelia,* with the last subgenus showing the weakest development of this character.

Schummelia shows certain distinct larval characters which make it easy to recognize. The semicircular row of hairs on the eighth segment is unique among the known tipulines, although certain species of *Yamatotipula* (e.g., *T. dejecta*) do have conspicuous clusters of macroscopic hairs near the lateral spiracular lobes. Some aquatic subgenera have dorsal lobes with extensive sclerotization, but *Schummelia,* particularly *T. variicornis,* shows the greatest development of this, with dark sclerotization both anteriorly and posteriorly. The lateral swellings on the eighth abdominal segment, the protuberant anal segment and the loss of certain macrosetae are also distinctive.

HABITATS OF *SCHUMMELIA:* Very little information is available concerning the larval habitats of the seven nearctic species of *Schummelia.* Rogers (1933) recorded the larvae of *T. synchroa* from "wet, black, organic silt of seepage areas" apparently in shaded or heavily wooded situations. Unreared larvae of *Schummelia,* possibly *T. hermannia,* were collected from moist, humous soil in a floodplain woods in Michigan by R. W. Merritt (G. W. Byers, personal communication). *Tipula variicornis* has been collected from "wet leaf mould or wet soil in marshy places or at the edges of ponds and streams, usually in woods" (Chiswell, 1956).

Subgenus *Serratipula* Alexander

I have examined larvae reared and associated with adults of two species of this small subgenus, *Tipula cylindrata* and *graminivora.* Although *T. graminivora* larvae have greater economic importance, *T. cylindrata* larvae are illustrated due to the superior preservation of available specimens.

Tipula (Serratipula) cylindrata Doane

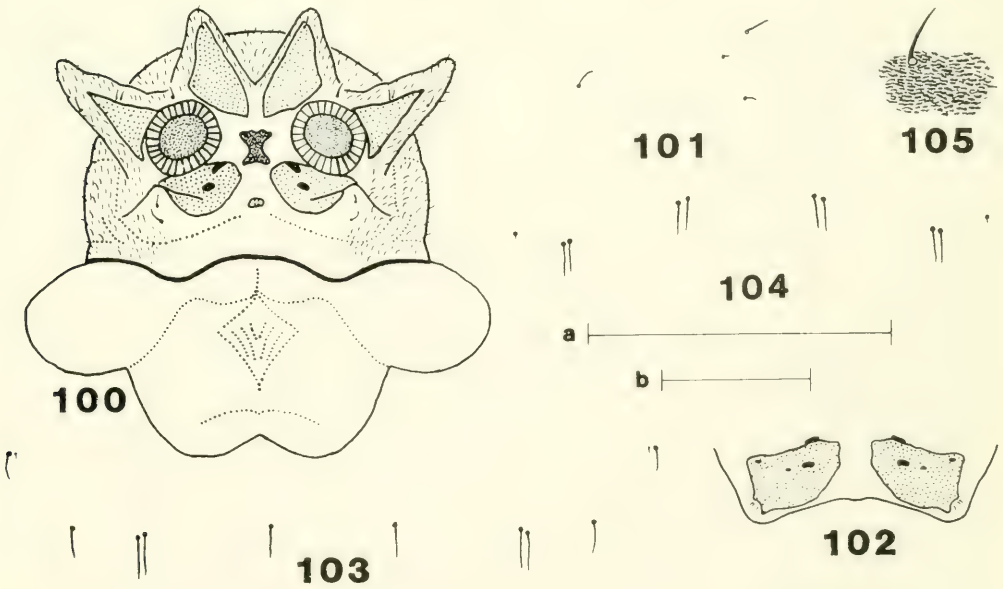
DESCRIPTION: Length 22.1 mm, width 3.6 mm, body light brown. *Abdomen:* Most macrosetae dark brown, setae D1-D4 and D6 long, D5 very short and pale (Fig. 103). Setae L1 and L4 long, L3 short, L2 very short, L1 dorsolateral to L2 (Fig. 101). Setae V2-V5 long, V1 very short and pale (Fig. 104). Short microscopic hairs generally in short, transverse rows on dorsum and venter (Fig. 105), longer microscopic and macroscopic hairs virtually absent; short microscopic hairs on pleura in regularly spaced groups of one to few. *Spiracular Disc:* Dorsal and lateral

lobes subconical, lateral lobes dorsolateral, dorsal lobes 3/4 length of lateral lobes (Fig. 100); lobes anteriorly with single long microscopic hairs; a single macroseta between dorsal and lateral lobes, three macrosetae on each lateral lobe at 1/2 to 3/4 length from base. A small seta near tip of each dorsal lobe. A light brown, roughly triangular sclerite posteriorly on each dorsal and lateral lobe, extending from spiracles to near apex. Each ventral lobe broadly triangular in posterior aspect, with subacute tip, basal width 2.5× length; two macrosetae on posterior surface. Inner surface of each lobe with light brown, irregular rectangular sclerite, with four scattered darker spots (Fig. 102). Spiracles circular, evenly brown. An irregular hourglass-shaped brown marking between spiracles; a light brown, oval spot between ventral lobes; remainder of spiracular disc pale. Marginal band brown. *Anal Segment:* Four short, rounded anal papillae (Fig. 100), lateral papillae length/basal width approximately 0.75 or less.

SPECIMENS EXAMINED: Two larvae from La Panza Creek, San Luis Obispo Co., California, C. D. Hynes, coll. (UCR). (One of the larvae is probably third instar and thus was not included in the above length and width measurements.)

SUBGENERIC DISCUSSION: *Serratipula,* based on *Tipula cylindrata* and *graminivora,* possesses a distinctive combination of characters. The light brown sclerites of the spiracular lobes are extensive, but do not encompass the apices of the lobes. These sclerites are roughly triangular on the dorsal and lateral lobes and more nearly rectangular on the ventral lobes. The spiracles are entirely light brown. The lateral pair of anal papillae is moderately developed in *T. cylindrata.* (The condition of the papillae in *T. graminivora* is not known due to the poor preservation of available material). Seta D4 is long, and the short microscopic hairs are arranged in transverse, short rows.

Serratipula shows similarities in a number of characters to other terrestrial subgenera, such as *Pterelachisus,* the *T. (Lunatipula) bicornis* group and some species of *Vestiplex.* The low, conical, spiracular lobes are most like those of *Pterelachisus.* The extensive sclerotization of the dorsal and lateral lobes is seen similarly in the *T. (Lunatipula) bicornis* group, although the sclerotization on the ventral lobes is most like that in some species of *Pterelachisus* (e.g., *T. trivit-*



Figs. 100-105. *Tipula (Serratipula) cylindrata.* 100, spiracular area. 101, pleural abdominal macrosetae. 102, ventral spiracular lobes, dorsal aspect. 103, dorsal abdominal macrosetae. 104, ventral abdominal macrosetae. 105, example of abdominal microscopic hairs and seta. All scale lines 1 mm. Scale a: Fig. 105, scale b: Figs. 100-104.

tata). A moderate development of the anal papillae is seen, much like the condition found in certain species of *Lunatipula* or *Vestiplex*. Dorsal and ventral setae D1-D3 and V3-V5 are long, and V1 and D5 are short, as in the *T. (Lunatipula) bicornis* group, *Pterelachisus* and *Vestiplex*. Setae D6 and V2 are long, as in the *T. (Lunatipula) bicornis* group.

Certain characters separate *Serratipula* from similar subgenera. Dorsal seta D4 is long, unlike the condition in *Pterelachisus*, the *T. (Lunatipula) bicornis* group, the *T. (Trichotipula) stonei* group, or *Vestiplex*. Seta D6 is long, unlike that of *Pterelachisus* and *Vestiplex*. The spiracles are completely brown in *Serratipula*, whereas, in the above subgenera, the inner circle is black or distinctly dark brown. The extensive sclerotization of the dorsal and lateral lobes is unlike the minor sclerotization found in *Pterelachisus*, the *T. (Trichotipula) stonei* group and certain species of *Vestiplex* (cf., *T. arctica*). The pronounced anal papillae differ from the reduced papillae of the *T. (Lunatipula) bicornis* group and the *T. (Trichotipula) stonei* group.

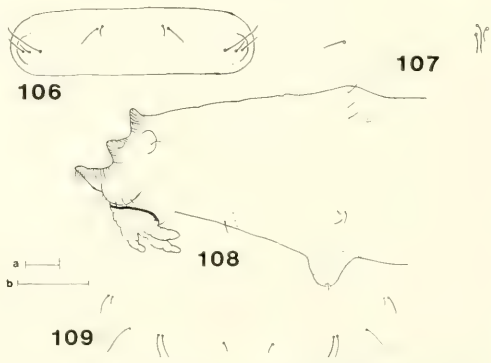
HABITATS OF *SERRATIPULA*: *Serratipula* is a subgenus of four species. Three of these are found only in California and the fourth occurs both in California and Oregon. Two species, *T. graminivora* and *tristis*, have been recorded as causing economic damage to pasture and rangelands by feeding on grasses (Alexander, 1967). Surprisingly, there have been only brief references to the larval habitats for these two species (Alexander 1921, 1967; Packard and Thompson 1929), and neither of the larvae has previously been illustrated. No habitat information was available with the specimens of *Tipula cylindrata* described above.

Subgenus *Sinotipula* Alexander

Tipula (Sinotipula) commiscibilis is the only species in this group for which the larvae have been associated with adults.

Tipula (Sinotipula) commiscibilis Doane

DESCRIPTION: Length 35.8-51.5 mm, width 5.0-6.4 mm, dorsum with a dark brown background; on each segment with two light brown, lateral longitudinal bands connected by median, transverse, irregular band; 2 pairs of light brown spots anterior to median band, four pairs of light brown spots posterior to band (Fig. 111). Pleura and venter brown. *Abdomen:* Posterior portions of abdominal segments I-VII with conspicuous, ventral transverse swellings (Fig. 108), increasing in height posteriorly, the most developed swellings with basal width twice height. Abdominal segment VIII with circular swellings anterior to but between dorsal and lateral spiracular lobes and anterolateral to each ventral lobe (Fig. 108). Macrosetae dark brown, setae D2-D4 and D6 long, D1 and D5 shorter (Fig. 109). Setae L2-L4 long, L1 shorter (Fig. 107). Setae on transverse swellings, V1, V3 and V4 long, V2 and V5 shorter (Fig. 106). Body with short microscopic hairs, in rows on dorsum and venter, single on pleuron (Fig. 112). Dorsal microscopic hairs forming overall light and dark "H"-pattern as described above; scattered small circular areas without microscopic hairs, surrounded by dark microscopic hairs. Macroscopic hairs absent. *Spiracular Disc:* Lateral and ventral spiracular lobes short, basal width slightly greater than length; dorsal spiracular lobes narrower, as long as wide. Lateral lobes equidistant from dorsal and ventral lobes (Fig. 110). Spiracular lobes with well-developed border of setae, longest setae less than ½ basal width of lobe. Posterior surface of each lobe pale; two to four dark spots at base of each ventral lobe; often a light brown sclerite lateral to spots. Spiracles small, circular, inner circle dark, outer ring brown; distance between spiracles twice or more diameter of spiracle. Marginal band brown. *Anal Segment:* Six, short anal

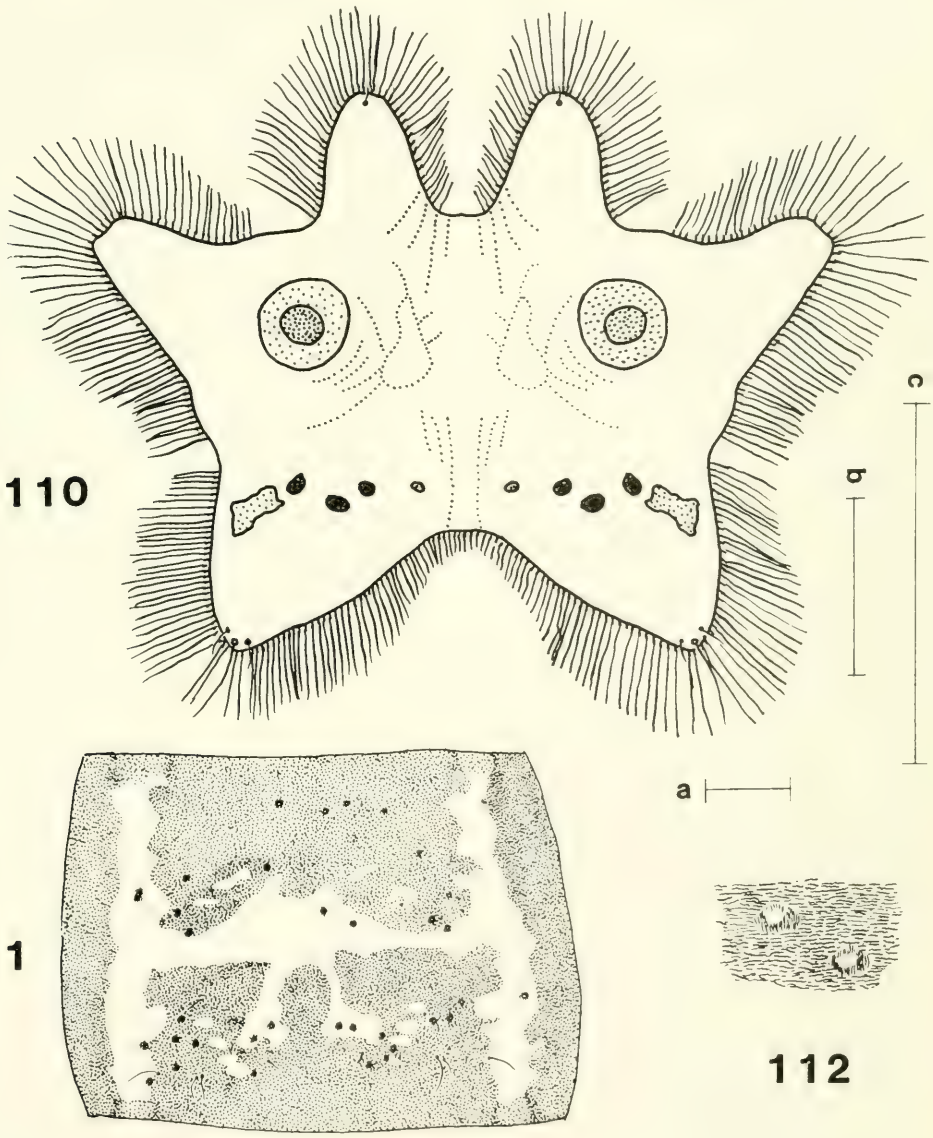


Figs. 106-109. *Tipula (Sinotipula) commiscibilis*. 106, ventral abdominal macrosetae on transverse swelling. 107, pleural abdominal macrosetae. 108, terminal abdominal segments, lateral view. 109, dorsal abdominal macrosetae. All scale lines 1 mm. Scale a: Fig. 108, scale b: Figs. 106, 107, 109.

papillae (Fig. 108), medial papillae paired, lateral papillae single; length/basal width of lateral papilla 2.0-3.0.

SPECIMENS EXAMINED: Four larvae were collected from Big Hill Creek, Big Hill Springs Provincial Park, approx. 33 km NW of Calgary, Alberta, G. Pritchard, coll. (KU).

SUBGENERIC DISCUSSION: *Sinotipula,* as judged by *Tipula commiscibilis,* shows a distinctive combination of features. An obvious character is the presence of ventral transverse swellings on the abdomen, found also in *Nippotipula* and, to a lesser extent, in *Yamatotipula* (specifically, *T. caloptera*). Both *T. caloptera* and *Sinotipula* also possess lateral swellings on abdominal segment VIII and a similar abdominal pattern formed by the dark and light, short micro-



Figs. 110-112. *Tipula (Sinotipula) commiscibilis.* 110, spiracular area. 111, abdominal segment, dorsal aspect. 112, example of microscopic hairs on abdomen. All scale lines 1 mm. Scale a: Fig. 111, scale b: Fig. 110, scale c: Fig. 112.

scopic hairs. Longer microscopic hairs are rare in *Sinotipula* and macroscopic hairs are absent. The spiracular lobes are short and broad with a well-developed border of setae as in other aquatic groups but the posterior surface of each lobe almost completely lacks darkened sclerites. The spiracles are small and widely separated, and the anal papillae are relatively short. None of the macrosetae is branched, although branched setae are found in most aquatic subgenera.

Few larvae of other subgenera could be confused with those of *Sinotipula.* The ventral abdominal swellings, microscopic hair pattern, small spiracles, total lack of macroscopic hairs, broad spiracular lobes and large mature size will serve to separate *Sinotipula* from other aquatic groups. *Yamatotipula* (specifically *T. caloptera*) is most similar in appearance to *Sinotipula,* although a few distinctions can be made between them. Of these, most important is the presence of clusters of macroscopic hairs on *T. caloptera* and the absence of macroscopic hairs in *Sinotipula.* Also lacking in *Sinotipula* is a dark median line on the ventral spiracular lobes, a character which all known larvae of *Yamatotipula* possess.

HABITATS OF *SINOTIPULA: Sinotipula* contains 19 nearctic species, all occurring in western North America. Larvae of *T. commiscibilis* described above were collected from a fairly fast-flowing creek, where they were under completely submerged rocks in the stream bed.

On a number of occasions, I have collected larvae which are very similar to those of *T. commiscibilis,* but I was unsuccessful in the two attempts to rear them. In an extremely fast run between two riffles, of the Cimarron River in Colfax Co., New Mexico, larvae were found under large rocks on the river bed, in water approximately 61 cm deep. They appeared to be the most abundant insect in terms of biomass, and were certainly the most common large insect. I have found larvae at other localities inhabiting similar situations, although not in the abundance seen in the Cimarron River.

Subgenus *Tipula* Linnaeus S. Str.

Only one species of this subgenus, *Tipula paludosa,* occurs in North America. It is an introduced species from Europe.

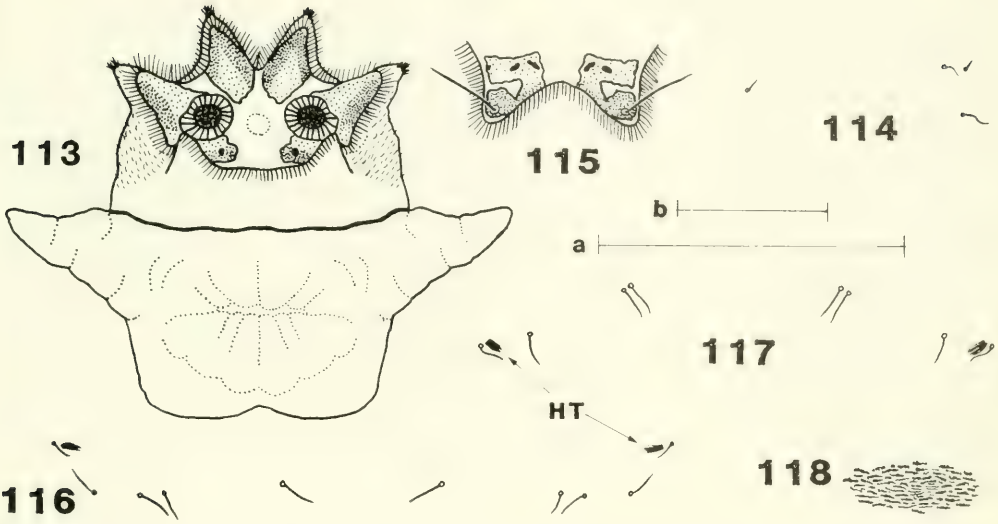
Tipula (Tipula) paludosa Meigen

Selected references: Hennig 1950:410, Figs. 216,222; Chiswell 1956:468-472, Figs. 91-93; Brindle 1960a:176-177, Fig. 1; Theowald 1967:27-28, Figs. 59-61.

DESCRIPTION: Length 23.3-38.0 mm, width 3.7-4.9 mm, body light brown, pleura often darker. Dark tufts of macroscopic hairs at base of each thoracic dorsal macroseta. *Abdomen:* Macrosetae black, all medium length; setae D5 and V2 absent (Figs. 114, 116, 117). Short microscopic hairs in short rows on dorsum and venter (Fig. 118), in groups of one to few hairs on pleura. Dark macroscopic hairs in tufts mediolateral to setae D6 and V1, and anterior to area between dorsal and lateral spiracular lobes, a few isolated hairs near seta D4. *Spiracular Disc:* All lobes subequal, as long as width at base, lateral lobes equidistant from dorsal and ventral lobes (Fig. 113). Lobes with complete border of short setae, longest setae approximately 1/5 basal width of ventral lobe. Most of posterior surface of each dorsal and lateral lobe sclerotized, sclerites darkest laterally. Inner surface of each ventral lobe with dark, C-shaped sclerite, apex darkest, three dark spots at base (Fig. 115). Spiracles roughly circular, inner circle black, outer ring brown; distance between spiracles less than or equal to diameter of a spiracle. Anterior surface of dorsal and lateral lobes with single microscopic hairs; macroscopic hair tufts at apex of each lobe. Marginal band brown. *Anal Segment:* Segment large, anal opening transverse. Four anal papillae (Fig. 113), lateral pair conical, length slightly longer than width at base, ventral pair as broadly rounded protuberances.

SPECIMENS EXAMINED: Over 50 larvae from the following localities in WASHINGTON: Skagit Co.: Mt. Vernon, R. Rosander, coll.; Burlington, J. Crawford and J. Ponnell, coll.; Whatcom Co.: Bellingham, L. Benedict, coll.; Birch Bay State Park, R. Rosander, coll.; Blaine, F. Nonini, coll.; Peace Arch, Knoblauch and Leckie, colls. (all WSU).

SUBGENERIC DISCUSSION: *Tipula paludosa* is an easily recognized larva. The dorsal and lateral spiracular lobes are only sclerotized on the basal three-fourths of each lobe, with the apical fourth remaining unsclerotized. A small apical tuft of mac-



Figs. 113-118. *Tipula (Tipula) paludosa.* 113, spiracular area. 114, pleural abdominal macrosetae. 115, ventral spiracular lobes, dorsal aspect. 116, dorsal abdominal macrosetae, with hair tufts; HT-hair tuft. 118, example of microscopic hairs on abdomen. All scale lines 1 mm. Scale a: Fig. 118, scale b: Figs. 113-117.

roscopic hairs is present on each of these lobes. Each ventral lobe is heavily sclerotized on the inner surface and closes against the spiracles, not against the dorsal and ventral lobes. The setae around the spiracular lobes are only of moderate length, but completely border each lobe. A particularly distinctive feature is the dark tufts of macroscopic hairs near abdominal setae V1 and D6, and near the thoracic setae as well. Abdominal setae V2 and D5 are absent (or possibly obscured by the macroscopic hair tufts).

The shape and placement of the spiracular lobes and the border of short setae show a similarity of *Tipula* s. str. to *Yamatotipula* and the non-nearctic *Acutipula.* Both *Acutipula* (*T. vittata* group sensu Theowald, 1957) and *Tipula* s. str. have tufts of macroscopic hairs on the apices of the dorsal and lateral lobes. The subgenera *Yamatotipula, Acutipula, Beringotipula* and *Tipula* s. str. all have patches of macroscopic hairs on the abdomen, although in *Tipula* s. str., these tufts are made up of a few closely set, dark hairs located near the setae, and originating from one small constricted area, differing from the larger clusters of hairs surrounding the setae in the other subgenera. The anal papillae are not elongate as in *Yamatotipula, Platytipula* and most of the other aquatic and semiaquatic groups but are most similar to those found in terrestrial and some semiaquatic groups such as *Beringotipula* and *Lunatipula.* At least one species of *Yamatotipula (T. ludoviciana)* however, has similarly short papillae. The unsclerotized apices and sclerotized bases of the dorsal and lateral lobes in *Tipula* s. str. resemble corresponding parts of the ventral lobes in *Beringotipula,* in which the unsclerotized apex is produced past the sclerotized base.

Tipula s. str. cannot be confused easily with any other subgenus. The general form of the spiracular disc, the complete border of short setae around the spiracular lobes, the small, distinct hair tufts and the small anal papillae make *T. paludosa* distinctive.

HABITATS OF SUBGENUS *TIPULA:* Although *T. paludosa* was accidentally introduced into North America, possibly in ballast from fishing vessels two or three centuries ago, *Tipula* is otherwise an Old World subgenus. The species has become established in Newfoundland and Nova Scotia (Alexander, 1967); recently it has also been found in British Columbia and

Washington (Jackson and Campbell, 1975).

In Europe, *T. paludosa* has been collected from a variety of habitats. Brindle (1960a) found the larvae most common in various pasture soils (peat, clay, sand, marl), but he also collected them in marshy peat soil, in *Hypnum* moss in wet places, and in aquatic mosses through which water slowly trickled. The larvae are well known as pests of many field crops (e.g., barley, rye, wheat) and pastures in Europe, attacking both the roots and shoots (Chiswell, 1956). In North America, based on collection data with the specimens I examined and published reports (Jackson and Campbell, 1975), *T. paludosa* appears to be a pest primarily of turf and pastures.

Subgenus *Trichotipula* Alexander

Of the 34 nearctic species of *Trichotipula,* only two, *Tipula oropezoides* and *T. stonei,* have been reared. The larvae of these species are quite distinct from one another and are discussed separately; in fact, the larvae of both species are at opposite extremes for the entire genus *Tipula* in terms of morpological characters and life histories.

Tipula (Trichotipula) oropezoides Johnson

Alexander 1920:1001-1002, Figs. 506, 513-518.

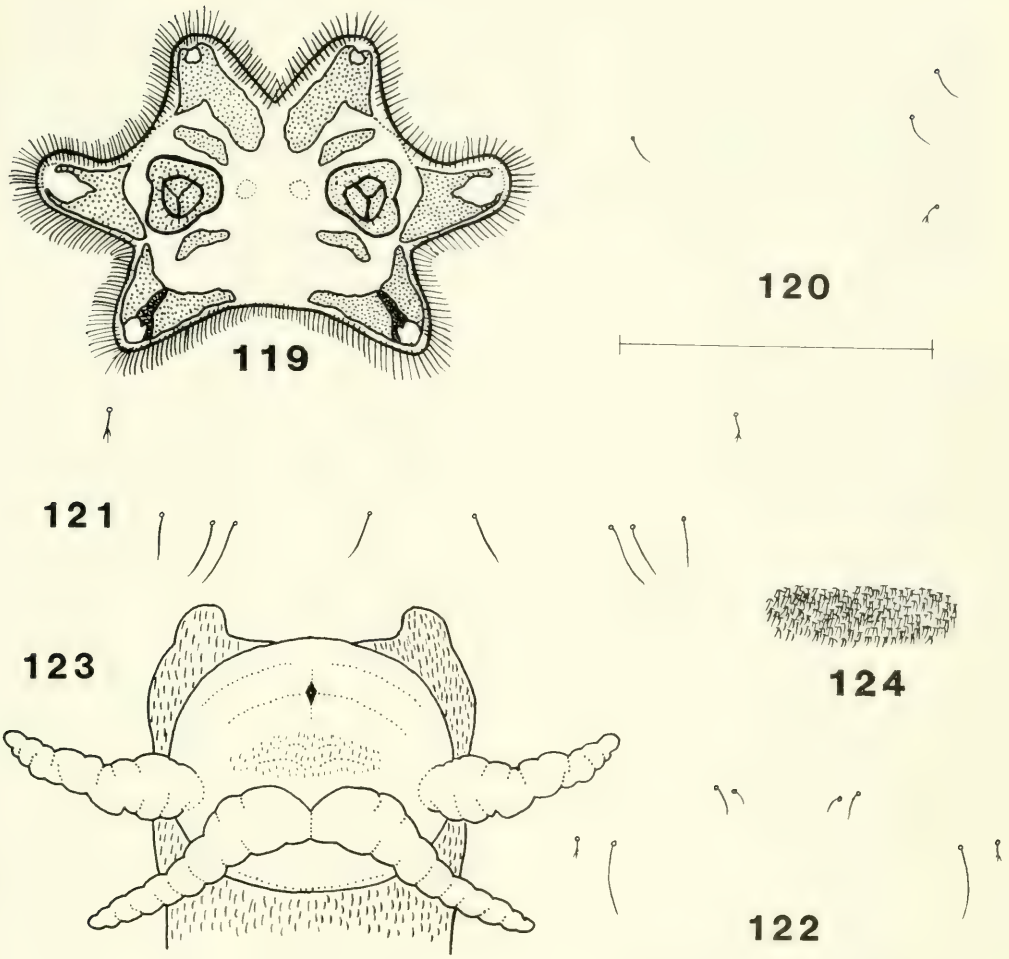
Description: Length 16.7-17.9 mm, width 1.9-2.1 mm, body brown. *Abdomen:* Most macrosetae brown, setae D1-D4 long, D6 shorter pale and branched, D5 absent (Fig. 121). Setae L1, L2 and L4 long, L1 dorsolateral to L2, L3 shorter, pale and branched (Fig. 120). Seta V3 long, V4 of medium length, V1 and V5 short, V1 pale and branched, V2 absent (Fig. 122). Abundant macroscopic hairs, single or in groups of two or three, densest on dorsum (Fig. 124). Microscopic hairs absent. *Spiracular Disc:* All lobes subequal, lobes approximately as long as width at base, lateral lobes equidistant from dorsal and ventral lobes (Fig. 119). Lobes with well-developed border of setae, longest setae 1/3 basal width of lobe. Posterior surface of all lobes with extensive brown sclerites; subcircular pale area at apex of each lobe. Ventral lobe with dark median line. An irregular, transverse brown sclerite above and below each spiracle. Spiracles brown, margins roughly trilobed, inner circle with dark, irregular "Y"-shaped pattern. Remainder of spiracular disc pale. Marginal band light brown. *Anal Segment:* Segment large and circular in ventral aspect; four, elongate anal papillae, with many constrictions along their length (Fig. 123), all papillae single and subequal, length/basal width 2.0-3.5.

Specimens Examined: Six larvae from Needham's Glen, Ithaca, Tompkins Co., New York, C.P.Alexander, coll. (UM, AMNH).

Discussion: Two unique features of *T. oropezoides* are the trilobed spiracles and the small, transverse sclerites located above and below each spiracle. No other *Tipula* is known to possess spiracles which are not circular or at least oval in shape, nor are there such prominent sclerites on the spiracular disc, as the sclerites are usually confined only to the lobes. Also distinctive for *T. oropezoides* are the four elongate anal papillae. In the other species of *Tipula* which have four papillae, these are equally short and conical, as in *Schummelia,* or the median pair is low and rounded, as in *Lunatipula* and some other terrestrial groups. The short spiracular lobes and setal border are similar to these structures in *Schummelia* and some species of *Savtshenkia.* A predominance of macroscopic hairs with an absence of microscopic hairs is seen in *Savtshenkia* (e.g., *T. ignobilis*) as well as *T. oropezoides.* Other taxa, such as *Platytipula, Angarotipula* and the genus *Holorusia,* have an overall "hairy" appearance due to an abundance of macroscopic hairs but microscopic hairs are also present.

Habitats of *Trichotipula* (*oropezoides* group): Alexander (1920) collected larvae of *T. oropezoides* from beneath saturated moss, apparently near the edge of a stream. Rogers (1933) reared the larvae in Florida from "moist to wet clumps of moss, on wet rocks, stream banks and roots." G. W. Byers collected pupae from mixed mosses and liverworts in a floodplain woods in Indiana (field notes).

It is not known how many of the 33 nearctic species of *Trichotipula* will eventually prove to have larvae and larval habitats similar to those of *T. oropezoides* but two species require mention here. Adults of *T. algonquin* were found in wet mossy habitats (Rogers, 1930), and the larvae possibly occur there. Adults of *T. unimaculata* have



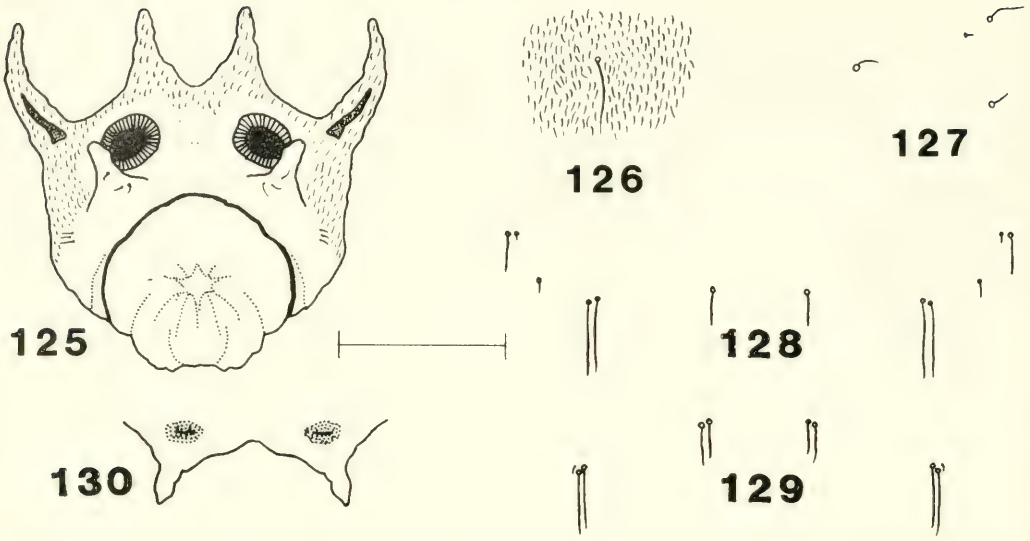
Figs. 119-124. *Tipula (Trichotipula) oropezoides.* 119, spiracular area. 120, pleural abdominal macrosetae. 121, dorsal abdominal macrosetae. 122, ventral abdominal macrosetae. 123, anal papillae, ventral aspect. 124, example of macroscopic hairs on abdomen. Scale line 1 mm.

also been found near wet areas (Rogers, 1942).

Tipula (Trichotipula) stonei Alexander

DESCRIPTION: Length 17.9 mm, width 2.9 mm, body white. *Abdomen:* All macrosetae dark brown, setae D1 and D6 of moderate length, D2 and D3 long, D4 short, D5 vestigial (Fig. 128). Setae L1 and L4 long, L3 of medium length, L2 short, L1 dorsolateral to L2 (Fig. 127). Setae V4 and V5 of moderate length, V2 and V3 long, V1 very short, close to V2 and V3 (Fig. 129). Dorsum and venter with sparse, single long microscopic hairs (Fig. 126); short microscopic and macroscopic hairs absent. Pleura without hairs. *Spiracular Disc:* All lobes conical, dorsal lobes 1.5× as long as width at base; lateral lobes dorsolateral, long, twice length of dorsal lobes; ventral lobes shorter, ⅔ length of dorsal lobes (Fig. 125). Posterior surface of each lateral lobe with thin, dark, medial sclerite, extending from base to midlength of lobe; remainder of lateral lobes and all of dorsal lobes with single, long microscopic hairs. Inner surface of each ventral lobe with light brown circular sclerite at base (Fig. 130). Spiracles approximately elliptical, inner circle black, outer ring brown. Remainder of spiracular area pale and glabrous. Marginal band light brown. *Anal Segment:* Segment small, without distinct papillae.

SPECIMENS EXAMINED: Three larvae from Baldwin Woods, Breidenthal Reserve, 17.7 km



Figs. 125-130. *Tipula (Trichotipula) stonei.* 125, spiracular area. 126, seta and example of abdominal microscopic hairs. 127, pleural abdominal macrosetae. 128, dorsal abdominal macrosetae. 129, ventral abdominal macrosetae. 130, ventral spiracular lobes, dorsal aspect. Scale line 1 mm.

SE of Lawrence, Douglas Co., Kansas, J. K. Gelhaus, coll. (JKG).

DISCUSSION: With a wide base and an elongate, conical form, the ventral spiracular lobes of *Tipula stonei* are distinctive among terrestrial *Tipula* larvae. The inner surface of each of these lobes is unsclerotized except for a light brown spot at the base. The dorsal and lateral lobes also lack appreciable sclerotization; only the posterior surface of each lateral lobe possesses a thin, dark sclerite. The anal segment is small and the anal papillae are not discernible. Single, long microscopic hairs only are on the dorsum and venter; the pleural regions of the abdomen completely lack hairs.

The dorsal and lateral spiracular lobes, each long, and with little sclerotization, are similar to those found in the genus *Nephrotoma* and some species of *Pterelachisus.* This virtual absence of sclerotization contrasts with the more extensive sclerites found in *Vestiplex* and *Lunatipula.* The ventral lobes are much more extended than those found in other terrestrial subgenera. Also striking is the complete absence of any distinct anal papillae in *T. stonei;* this is equivalent only to the condition in the *T. disjuncta* group and *Odonatisca.* Overall, the larva of *T. stonei* shows little similarity to *T. oropezoides,* although they are both placed in the same subgenus.

The larva of *Tipula stonei* can be easily separated from other similar groups. The occurrence of only scattered, long microscopic hairs separates *T. stonei* from other terrestrial subgenera, all of which have a predominance of short microscopic hairs in short rows. The sclerotized, prothoracic welts, unique to the genus *Nephrotoma,* separate it from *T. stonei.*

HABITATS OF *TRICHOTIPULA* (*STONEI* GROUP): Larvae of *T. stonei* were collected under dry leaves in soil 1.3 cm below the surface, on a heavily forested hillside in Kansas, in August. The larvae appear to grow and develop during the hot, dry conditions of summer and do not aestivate or move to moister levels of soil. This is probably significant in terms of the subgenus as a whole, for most of the 33 nearctic species are found in the arid West. It is probable that the larvae of these species will be found in terrestrial situations such as described for *T. stonei,* rather than seepages and wet mosses where *T. oropezoides* has been found.

Subgenus *Triplicitipula* Alexander

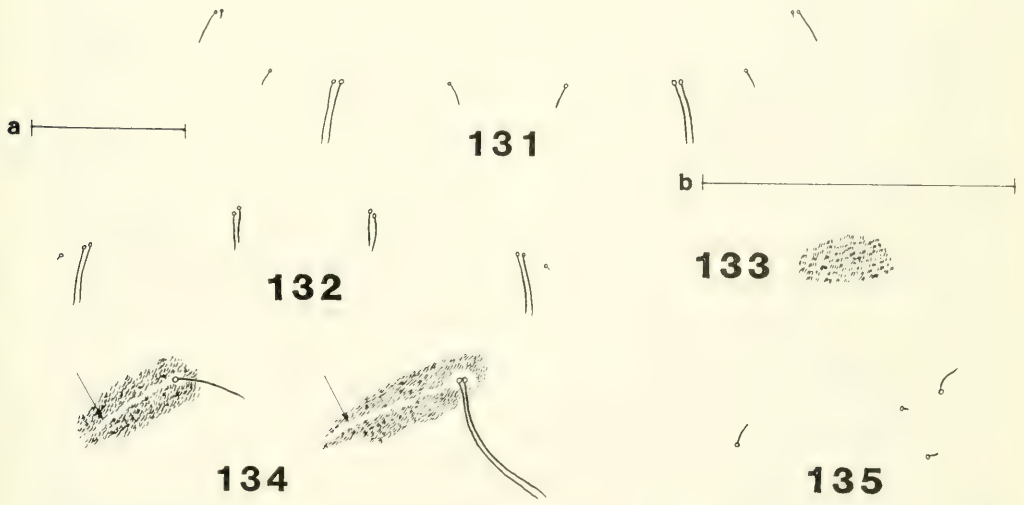
I have examined larvae reared and associated with adults for four species in this subgenus.

Tipula (Triplicitipula) triplex Walker

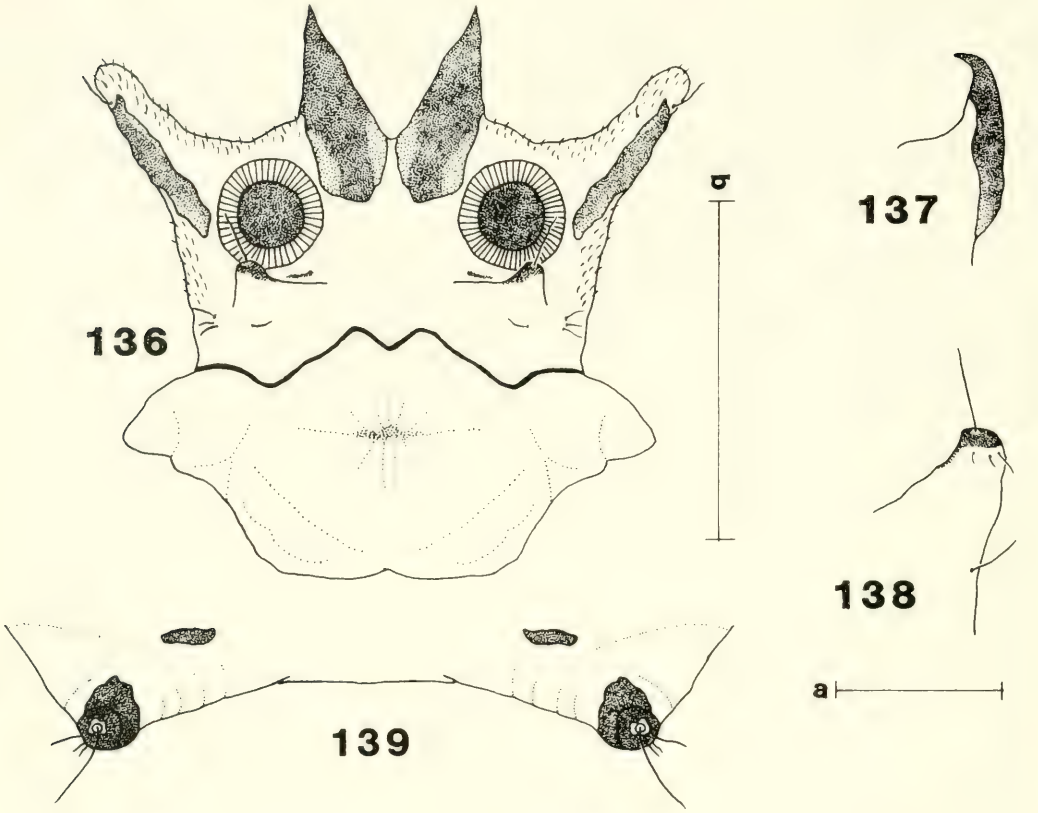
DESCRIPTION: Length: 26.5-32.9 mm, width 3.9-4.6 mm, body brown. *Abdomen:* All macrosetae dark brown to black, setae D2 and D3 long, D6 slightly shorter, D1 and D4 short, D5 very short (Fig. 131). Setae L1 and L4 long, L2 and L3 short and appressed (Fig. 135). Setae V2 and V3 long, V4 and V5 slightly shorter, V1 very short (Fig. 132). Short microscopic hairs in short rows on dorsum and venter (Fig. 133), single on pleura. Microscopic hairs on dorsum dense and longer around bases of setae D1-D4 and on segment VIII; narrow areas without hairs, originating from bases of D1-D3 and extending medioposteriorly for approximately length of setae (Fig. 134). *Spiracular Disc:* Dorsal and lateral lobes subconical, lateral lobes dorsolateral, close to dorsal lobes, lateral lobes slightly longer than dorsal lobes (Fig. 136). Ventral lobes small, short, narrow basally, basal width of each twice its length, apex of each truncated (Fig. 138). Posterior surface of each dorsal lobe with complete, dark sclerite, extending from between spiracles to apex of lobe, distal third of lobe sclerotized anteriorly and posteriorly, apex of lobe an acute, anteriorly directed point (Fig. 137). Posterior surface of each lateral lobe with lateral sclerite, apex of lobe unsclerotized. Distal third of each ventral lobe with dark sclerite, a large seta arising from a pale spot at apex; a black spot at base of lobe (Fig. 139). Spiracles large, circular, outer circle dark brown, inner circle black. Remainder of spiracular disc pale. Marginal band dark brown. *Anal Segment:* Four anal papillae, lateral papillae small, width at base 1.5× length, ventral papillae broadly rounded. Anal opening horizontal.

SPECIMENS EXAMINED: Ten larvae from: KANSAS: Douglas Co., Lawrence, along Kansas River, G.W.Byers, coll. (KU); Douglas Co., Hole-in-the-Rock, 8.0 km W of Baldwin City, J.K.Gelhaus, coll. (JKG); NORTH CAROLINA: Forsyth Co., approximately 6.4 km W of Stokesdale, W.H.Bailey, coll. (NC).

SUBGENERIC DISCUSSION: Larvae have been associated for six species of *Triplicitipula,* four which I have examined *(T. aequalis, integra, praecisa* and *triplex)* and two *(T. acuta, simplex)* described by Hartman and Hynes (1982). Although not unique to *Triplicitipula,* one obvious feature of all of these species is the extensive sclerotization of both the dorsal and lateral lobes. In particular, the sclerites of the dorsal lobes include the apices and form anteriorly directed points. The one known exception is



Figs. 131-135. *Tipula (Triplicitipula) triplex.* 131, dorsal abdominal macrosetae. 132, ventral abdominal macrosetae. 133, example of microscopic hairs on abdomen. 134, abdominal microscopic hairs and seta, showing "setal imprints." 135, pleural abdominal macrosetae. All scale lines 1 mm. Scale a: 131, 132, 135, scale b: 133, 134.



Figs. 136-139. *Tipula (Triplicitipula) triplex.* 136, spiracular area. 137, dorsal spiracular lobe, lateral aspect. 138, ventral spiracular lobe, lateral aspect. 139, ventral spiracular lobes, dorsal aspect. Scale lines 1 mm. Scale a: Figs. 136, 137, scale b: Figs. 138, 139.

T. simplex; in this species, the dorsal lobes are largely sclerotized, but the apices remain unsclerotized. The lateral lobes in *Triplicitipula* are sclerotized only on the lateral half. Each ventral lobe is roughly trapezoidal with a truncated apex and a single, long hair arising from its center. The inner, distal third of this lobe is darkly sclerotized and one or two black spots are located at the base in all the known species. The spiracles are large, circular, and dark. The lateral anal papillae may be slightly developed or absent. The arrangement of the macrosetae is similar in all of the species examined except the length of seta D4 varies; it may be shorter or longer than D2 and D3. The microscopic hairs are short, dark and dense, with conspicuous "setal imprints", that is, bare areas of the cuticle extending medioposteriorly from the base of certain macrosetae which indicate the density of the microscopic hairs.

Triplicitipula is similar in overall form to *Hesperotipula* and both possess truncated, darkly sclerotized ventral lobes and similar densities of microscopic hairs, including "setal imprints". As discussed previously, all studied species of *Triplicitipula* except *T. simplex* have heavily sclerotized dorsal lobes with distinct, curved points at their apices. This is found as well in *Hesperotipula,* some species of *Vestiplex* and most known species *Lunatipula* (*T. fuliginosa* and *T. lunata* groups). However, in *T. simplex* the dorsal lobes with unsclerotized apices are most comparable to the condition in the *T. bicornis* group of *Lunatipula.* Larvae of *Triplicitipula* can be separated from those of most *Lunatipula* by the shape of the ventral lobes. These lobes have a truncate, darkly

sclerotized apex and possess a single, long apical seta in *Triplicitipula;* in *Lunatipula,* the ventral lobes have rounded to only slightly truncated apices, the pattern of sclerotization varies but is not as it is in *Triplicitipula,* and there is never a long, erect, apical seta. Additionally, the microscopic hairs in *Triplicitipula* are longer and more dense than on the *T. fuliginosa* group of *Lunatipula. Hesperotipula* possesses ventral lobes with a shape like those in *Triplicitipula,* but these lack the basal spot. Also, the "setal imprints" in *Hesperotipula* are quite faint, and the rows of microscopic hairs are distinctly separated.

HABITATS OF *TRIPLICITIPULA: Triplicitipula* contains nearly 25 nearctic species. Many of the species are found in grasslands. In California, *T. simplex* and *quaylii* cause serious, localized damage to pasturelands by eating the grass roots and shoots (Hartman and Hynes, 1977; Packard and Thompson, 1921). These two species, along with certain species of *Serratipula,* are commonly called "range crane flies." Others, such as *T. acuta* and *silvestra,* occur in similar habitats but do not appear to cause extensive damage. Larvae of *T. triplex* have been collected in North Carolina in soil under clumps of dead orchardgrass (collection label, NC).

Wooded areas are also inhabited by larvae of *Triplicitipula.* I have collected larvae of *T. integra* in Kansas from wet, sandy soil under leaf litter in a mixed deciduous woods, as well as under accumulations of dry leaves in an open grassy area bordering a woods; *T. triplex* has been reared from similar situations. In California, *T. praecisa* was reared from "decaying leaves" (Alexander, 1967) and I have collected larvae of *T. aequalis* in damp, sandy soil under a 1.3 cm layer of oak, fig and horsechestnut leaves.

Subgenus *Vestiplex* Bezzi

I have examined larvae reared and associated with adults for two species of this subgenus, *Tipula arctica* and *T. platymera.*

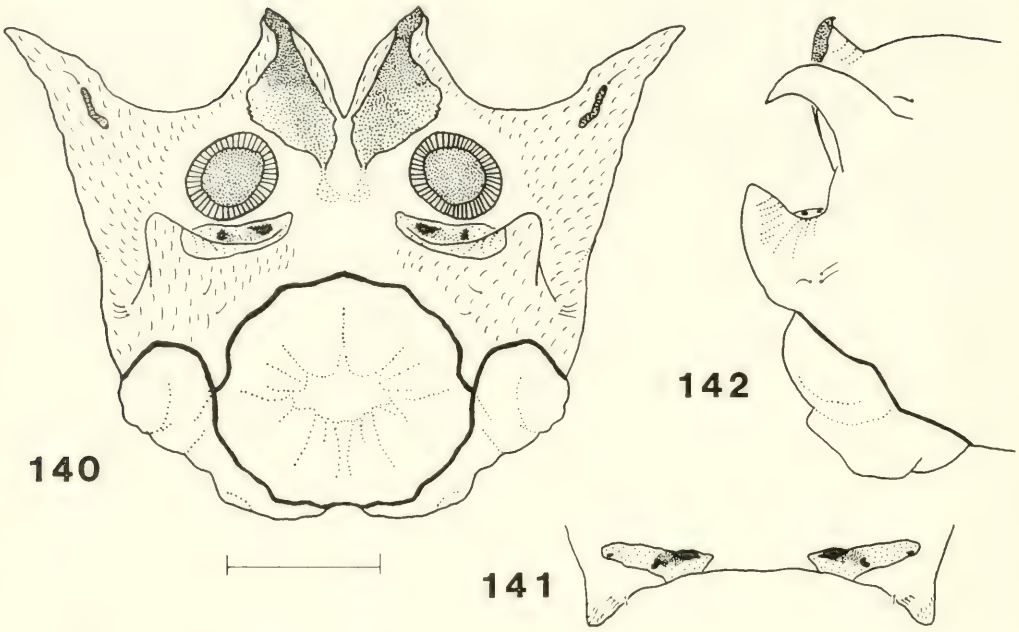
Tipula (Vestiplex) platymera Walker

Teale and Gelhaus 1984:424-427, Figs. 9-16.

DESCRIPTION: Length 26.7-34.9 mm, width 4.3-5.9 mm, body yellowish brown. *Abdomen:* Most macrosetae dark brown, setae D1-D3 long, D4-D6 short and appressed, D5 pale (Fig. 143). Setae L2 and L3 very short, L1 and L4 long, L1 dorsolateral to L2. Setae V2-V5 long, V1 very short (Fig. 144). Short microscopic hairs in long rows on dorsum and venter, single on pleura. *Spiracular Disc:* Dorsal and lateral lobes subconical, lateral lobes dorsolateral; dorsal lobe $^2/_3$ length of lateral lobe (Fig. 140). Ventral lobes small, triangular in posterior aspect, basal width of each approximately twice length of lobe. Posterior surface of each dorsal lobe with irregular sclerite extending from base to apex, apex a short, sclerotized, anteriorly directed point (Fig. 142). Each lateral lobe with thin, dark sclerite, from near base to midlength of lobe. Inner surface of each ventral lobe with three dark basal spots, pale brown sclerite surrounding spots and extending onto outer surface (Fig. 141). Remainder of lobes with single microscopic hairs. Spiracles approximately circular, inner circle black, outer ring brown; a pair of light brown areas between spiracles. Remainder of area around spiracles white and glabrous. Marginal band brown. *Anal Segment:* Four, broadly rounded anal papillae (Fig. 140), a brown band extending between anus and papillae, and connecting to marginal band.

SPECIMENS EXAMINED: Fifteen larvae from Silver Lake, 30 km W of Centennial, Carbon Co., Wyoming, S. Teale, coll. (ST,JKG).

SUBGENERIC DISCUSSION: Larvae are known for two of the seventeen nearctic species of *Vestiplex,* and for eight palearctic species. The most important synapomorphy seen in all these species is a brown band separating the anus from the anal papillae. This is a unique feature among the subgenera of *Tipula.* The posterior surface of each dorsal spiracular lobe is broadly sclerotized, and in some species, the sclerotization encompasses the apex of the lobe and forms an acute point. In the palearctic *T. virgatula montivaga* each dorsal lobe has a dark sclerite at both the base and apex, with an unsclerotized region separating these two sclerites. Each lateral lobe usually possesses a thin, more or less vertical sclerite, but this may be entirely absent in some species. The ventral lobes are broadly triangular, varying from a moderate development in *T. platymera* and the palearctic *T. scripta,* to scarcely evident in *T. virgatula montivaga.* In most



Figs. 140-142. *Tipula (Vestiplex) platymera.* 140, spiracular area. 141, ventral spiracular lobes, dorsal aspect. 142, terminal abdominal segments, lateral aspect. Scale line 1 mm.

species each ventral lobe has only a narrow band of sclerotization extending across its inner surface. These sclerites are more extensive in *T. scripta* and *leucoprocta,* in which most of the inner surface is dark, and less extensive in *T. kashkarovi* and *virgatula montivaga,* where only a small irregular sclerite is present. The lateral anal papillae are moderately developed in many species, although they are reduced in a few, such as *T. platymera.* The macrosetal arrangement appears to be consistent in those species for which this information could be obtained *(T. platymera, arctica, scripta),* including short setae D4-D6. According to Theowald (1957, 1967) and Alexander (1919), seta V1 is absent in *T. scripta* and *arctica,* but the seta is very reduced in *T. platymera* and may have been overlooked in these other two species. Short microscopic hairs are arranged in rows and cover most of the abdomen; macroscopic hairs are mostly absent.

Figs. 143-144. *Tipula (Vestiplex) platymera.* 143, dorsal abdominal macrosetae. 144, ventral abdominal macrosetae. Scale line 1 mm.

The conical dorsal and lateral spiracular lobes and the reduced, broadly triangular ventral lobes in *Vestiplex* are similar overall to those in *Pterelachisus, Lunatipula* and *Serratipula.* In *T. platymera* and other related species, the dorsal lobes are sclerotized to the apex, being similar to those in most *Lunatipula.* The dorsal lobes in other species of *Vestiplex,* including *T. arctica,* have varying degrees of sclerotization, but the sclerites do not include the apices of the lobes; the lobes are similar to those of *Pterelachisus, Serratipula* and the *T. (Lunatipula) bicornis* group. The lack of appreciable sclerotization of the lateral lobes, and the macrosetal arrangement and size, particularly a short and appressed seta D6, are characteristics shared by both *Vestiplex* and *Pterelachisus.*

One character, the brown band dividing

the anus from the papillae, serves to separate all known *Vestiplex* from other *Tipula*. All other groups possess only the marginal band separating the anal segment from the spiracular disc.

HABITATS OF *VESTIPLEX:* The larvae of *T. platymera* were found in soil under a layer of conifer needles, 2.5 to 5.0 cm thick, in a spruce-pine forest (Teale and Gelhaus, 1984). *Tipula arctica* has been reared from soil under *Cassiope* (Nielsen, 1910) in Greenland, and generally in damp soil in arctic areas (Theowald, 1967). The pupae of *T. longiventris* were collected "below the surface of damp friable woodland soil, beneath an inch-deep layer of leaf mold" and a female was found ovipositing in the "leaf mold and soil near the lower edge of an oak-hickory slope" in Michigan (Rogers, 1942). *Tipula bergrothiana* was reared from a pupa collected in a mossy ground cover in a spruce woods in Alaska (G. W. Byers, field notes). Nearctic *Vestiplex* are characteristic of mountainous or more northern regions.

The palearctic *T. scripta* and *T. hortorum* have been reared from moist soil and leaf litter in deciduous woods (Chiswell, 1956; Theowald, 1957). *Tipula nubeculosa* has been found "in soil in coniferous woods" (Chiswell, 1956). *Tipula excisa* and *montana* were both collected in damp tundra soil, in damp mountain meadows and scree slopes (Theowald, 1967). Vtorov and Savchenko (1968) record *T. leucoprocta* from the mossy spruce forest and meadow ecotone in subalpine areas.

Subgenus *Yamatotipula* Matsumura

I have chosen to describe and illustrate *Tipula (Yamatotipula) strepens,* due to the availability of specimens from several areas within its range.

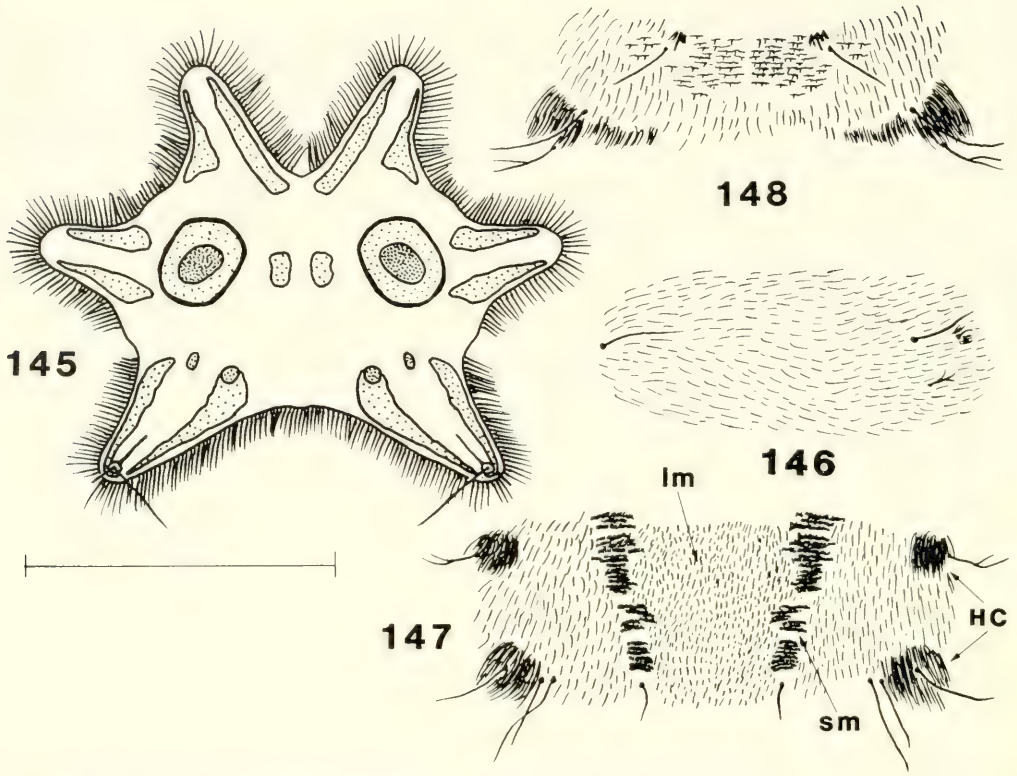
Tipula (Yamatotipula) strepens Loew

Alexander and Byers 1981: Fig. 72.

DESCRIPTION: Length 28.7-34.7 mm, width 3.0-3.9 mm (specimens completely laboratory reared: length 22.3-24.0 mm, width 2.0-2.3 mm), body yellowish-brown. *Abdomen:* Most macrosetae dark brown, setae D2-D4 long, D1, D5 and D6 shorter, D6 pale and branched (Fig. 147). Setae L2 and L4 long, L1 and L3 shorter, L3 pale and branched (Fig. 146). Setae V3 and V4 long, V1 and V2 shorter, V5 very short, V1 pale and branched (Fig. 148). Long and short microscopic hairs and macroscopic hairs present; macroscopic hairs conspicuous, in clusters around setae D4, D5 and V2 (obscuring D5 and V2), on dorsum of segment VIII, and in cluster between dorsal and lateral spiracular lobes. Black short microscopic hairs in long, transverse rows, overall forming two, irregular, longitudinal lines on dorsum (Figs. 147, 151); long microscopic hairs brown and generally distributed. *Spiracular Disc:* All lobes subequal, as long as basal width, lateral lobes equidistant from dorsal and ventral lobes (Fig. 145). Lobes with well-developed border of setae, longest setae 1/3 basal width of lobe. Posterior surface of each lobe usually with two light brown, lateral sclerites. Each ventral lobe with a dark, median line; two dark spots at base. Two macrosetae, one long and one short, at apex of ventral lobe. Spiracles large, approximately circular, inner circle dark brown, outer ring brown; distance between spiracles 1-1.5× diameter of spiracle. Two light brown spots between spiracles may be conspicuous; remainder of spiracular disc pale. Marginal band light brown. *Anal Segment:* Six elongate anal papillae, medial papillae paired, lateral papillae single (Fig. 149), length/basal width of lateral papilla 6.5-8.0.

SPECIMENS EXAMINED: Thirteen larvae from the following localities: KANSAS: Douglas Co., Lawrence vicinity, J. Gelhaus, coll. (JKG); all following collected by H. Teskey (CNC): NEW JERSEY: Montague Co.; NEW YORK: Oswego Co., St. Mary's Pond; Cattaraugus Co., Little Valley, outlet Pigeon Valley Swamp; ONTARIO: Alfred Bog; QUEBEC: Perkins sur le Lac, approx. 21 km NW of Ottawa (Ontario).

SUBGENERIC DISCUSSION: I have studied associated larvae for 15 of the 50 nearctic species of *Yamatotipula* and know one additional species only from the published description. Larvae have also been described for seven palearctic species. All known *Yamatotipula* have distinct clusters of macroscopic hairs surrounding setae D5 and V2, and on the dorsum of the eighth abdominal segment, anterior to the area between the dorsal and lateral lobes. Often, a distinct cluster is present between setae D2 and D4, surrounding D3. The body also possesses a combination of short and long microscopic hairs. For example, in *T. caloptera* and certain other species, the body is covered almost exclusively with short



Figs. 145-148. *Tipula (Yamatotipula) strepens.* 145, spiracular area. 146, pleural abdominal macrosetae and hairs. 147, dorsal abdominal macrosetae and hairs; HC-hair cluster, lm-long microscopic hairs, sm-short microscopic hairs. 148, ventral abdominal macrosetae and hairs. Scale line 1 mm.

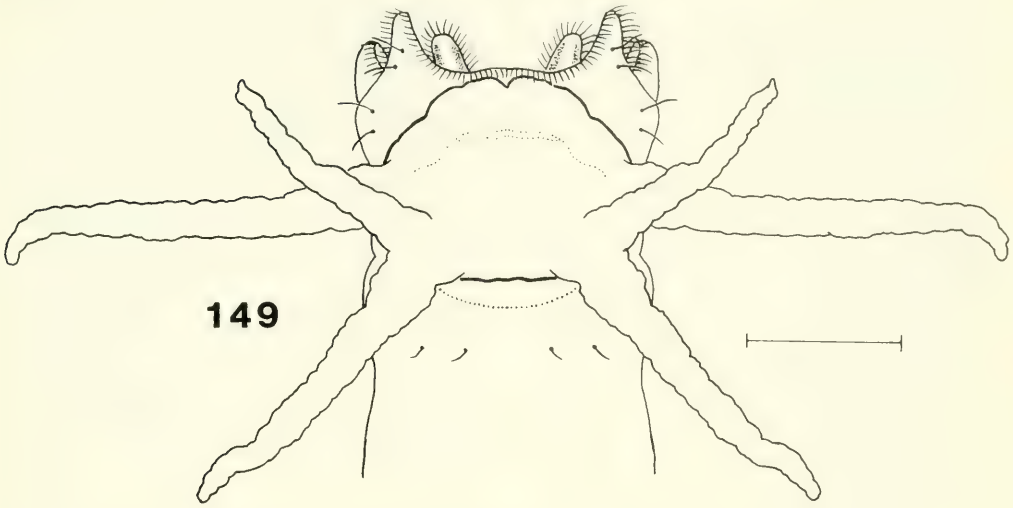
microscopic hairs, organized in rows, with macroscopic hairs only in isolated clusters. In *T. strepens* and others, the long microscopic hairs are more predominant, with macroscopic hairs in clusters. In these latter larval types, the short microscopic hairs are less visible and often distributed in small groups.

The short microscopic hairs may additionally form distinctive patterns. The hairs may be dark and organized into distinct, dorsal stripes (Fig. 151) as found, for example, in *T. strepens.* In *T. caloptera* the combination of light and dark short microscopic hairs forms a distinct pattern of spotting on the dorsum (Fig. 150). The palearctic *T. pruinosa* group and nearctic *T. sulphurea* have a distinct pattern formed by paired, transverse rows of macroscopic hair tufts on the anterior portions of the abdominal segments, in addition to the tufts around the macrosetae. Many species of *Yamatotipula,* however, have no distinct hair patterns.

The spiracular lobes are all approximately equal in length, usually as long as wide, with a well-developed border of setae. The spiracles are large and oval to circular in shape. Although the patterning on the posterior surfaces of the lobes varies among the species examined, often the lobes have darker, lateral sclerites. All *Yamatotipula* known have a dark median line on each ventral lobe.

Six anal papillae are present in most species. Two pairs of papillae are usually long, with the anteriomedial pair often shortened. In some species this shortened medial pair is absent and only four papillae are present. For example, the palearctic *T. solstitialis* has only four long papillae. The nearctic *T. ludoviciana* has only four short papillae.

In *T. caloptera* there are very reduced,



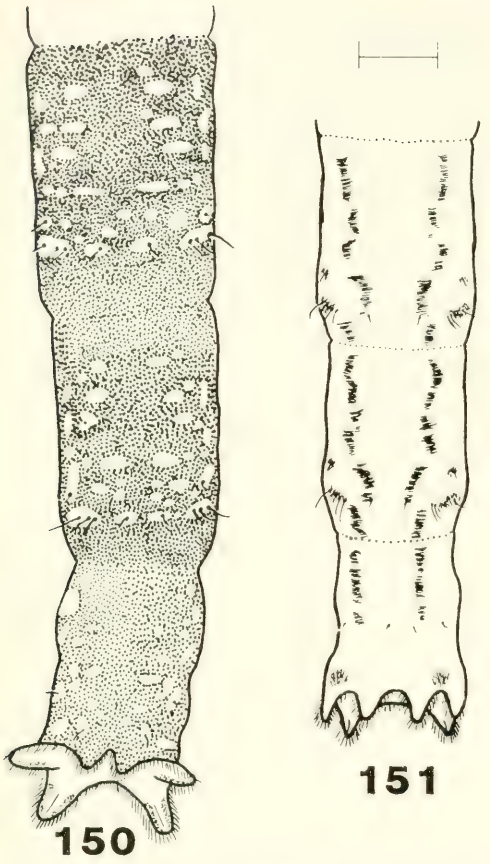
Figs. 149. *Tipula (Yamatotipula) strepens.* Anal papillae, ventral aspect. Scale line 1mm.

transverse abdominal swellings.

Yamatotipula shows similarities to other aquatic and semiaquatic subgenera. The radially arranged, subequal, spiracular lobes with a well-developed border of setae, branched setae D6, L3 and V1, and long anal papillae are characters shared by many aquatic and semiaquatic groups such as *Platytipula, Bellardina,* and *Nobilotipula.* The clusters of macroscopic hairs near macrosetae D5 and V2 are found also in *Beringotipula* and the non-nearctic *Acutipula. Tipula* s. str. has similarly placed patches of macroscopic hairs but they are very dark, few in number, and do not surround the setae, thus forming discrete tufts rather than the more diffuse clusters of *Yamatotipula.* The predominance of short microscopic hairs in a pattern of light and dark areas and transverse abdominal swellings seen in *T. caloptera* are found also in *Sinotipula.*

The distinct, longitudinal microscopic hair patterns as in *T. strepens* and other species and the transverse macroscopic hair patterns found in *T. sulphurea* are unique for *Yamatotipula,* and the larvae cannot be confused with those in any other known group. *Tipula caloptera* also has a distinct abdominal pattern which can only be confused with that of *Sinotipula. Tipula caloptera,* though, possesses macroscopic hair clusters and long anal papillae, while these clusters of hairs are absent and the papillae are short in *Sinotipula.* Species of *Yamatotipula* that lack these distinct patterns can be separated from the similar subgenera *Platytipula* and *Bellardina* and the genus *Holorusia* by the distinct clusters of hairs. *Tipula ludoviciana* has four, short, anal papillae and might be confused with *T. (Tipula) paludosa.* The ventral papillae in *T. ludoviciana,* however, have pointed apices while in *T. paludosa,* they are reduced to low, rounded protuberances; the patches of hairs are different in *Yamatotipula* and *Tipula* s. str. as discussed previously.

HABITATS OF *YAMATOTIPULA:* Larvae of *Yamatotipula* are found in a wide variety of aquatic and semiaquatic situations. Larvae of *T. strepens* are "semiaquatic in the moss and algal mats of the rills and trickles" (Rogers, 1942), and H. Teskey collected this species from wet mosses on stream banks (collection label, CNC). *Tipula caloptera* is recorded from Florida in "wet or submerged mats of mosses and algae" (Rogers, 1933), and I have collected the larvae from mosses in a cold spring-fed stream in Kansas. Rogers (1933) also notes that in *T. caloptera* the "larvae can live for months wholly submerged in well-aerated streams." A pupal skin of *T. brevifurcata* "projected from the wet mosses and algae



Figs. 150-151. *Tipula (Yamatotipula)* spp. 150, *T. (Y.) caloptera,* terminal abdominal segments, dorsal aspect. 151, *T. (Y.) strepens,* terminal abdominal segments, dorsal aspect. Scale line 1 mm.

at the brink of a small shaded falls'' (Rogers, 1930). *Tipula concava* has been collected in Tennessee from the coarse sand about the roots of *Dianthera (=Justicia) americana* at the water's margin (Rogers, 1930), although I have collected it in Kansas from exposed tree root clumps and in leaf debris at stream edges. These stream margins are where I have commonly collected larvae of *T. furca,* either in wet, decaying leaf debris or in the sand and muck at the stream edge. Hynes (1957) notes that the larvae of *T. fraterna* are found in damp, steep, stream banks, which are usually covered with mosses and liverworts. In Kansas, I have found *T. tricolor* in leaf debris or mosses from springs and spring-fed streams.

Many larvae of *Yamatotipula* have been recorded from marshy areas with much silt and organic debris. *Tipula furca, sulphurea* and *subeluta* have been reared from the muddy margins of pools (Rogers 1933, 1942). *Tipula dejecta* was collected in thick organic matter in an alder swamp (Alexander, 1920). Rogers (1933) records a number of species, for example, *T. manahatta,* from ''wet plastic soils of grass and sedge marshes.'' The larva of *T. footeana* was found among grass roots on an unshaded mudflat surrounding a lake in Idaho (Foote, 1963).

The known habitats of seven palearctic species are similar to those discussed here.

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THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN

A Review of the Tribes Diphaglossini and Dissoglottini (Hymenoptera, Colletidae)

By
Charles D. Michener

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A Review of the Tribes Diphaglossini and Dissoglottini (Hymenoptera, Colletidae)

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Abstract

A key to the three tribes of the Neotropical subfamily Diphaglossinae is presented, together with keys to the genera of the tribes Diphaglossini and Dissoglottini. The generic apomorphies in all three tribes are summarized in a cladogram. The Diphaglossini includes *Cadegualina* new genus for *Bicornelia andina* Friese and *sericata* Friese; *Cadeguala* (= *Policana*, new synonym) for *C. occidentalis* (Haliday) and *albopilosa* (Spinola), new combination; and *Diphaglossa* for *D. gayi* Spinola.

The tribe Dissoglottini (of which Mydrosomatini and Ptiloglossidiini are new synonyms) contains *Ptiloglossidia* for *P. fallax* Moure; *Mydrosomella* new genus for *Diphaglossa gaullei* Vachal, and *Mydrosoma* (= *Bicornelia* and *Dissoglotta* new synonyms) for the following species: *opalinum* (Smith) = *metallicum* Smith; *brooksi* new species; *saussurei* (Vachal), new combination, transferred from *Diphaglossa; aterrimum* (Friese), new combination, from *Bicornelia* = ? *stenoceratina* Moure (from *Dissoglotta*); *longitarse* (Friese), new combination, from *Bicornelia; inusitatum* (Snelling), new combination, from *Bicornelia; serratum* (Friese), new combination, from *Bicornelia; bohartorum* new species; and *sinaloa* new species.

Introduction

The tribes of the largely Neotropical colletid subfamily Diphaglossinae were reviewed by Michener (1966). Since that time additional material has become available and a new review of certain groups is needed. The genera of both the Diphaglossini and Dissoglottini are treated. For the former, species and their synonymies and main characters are included, while for the latter all known species are described in detail.

The subfamily Diphaglossinae differs from other Colletidae in two strong synapomorphies: (1) a small stigma, shorter than the prestigma and not wider than the distance from the inner margin of the prestigma to the costal margin of the wing, and (2) the strongly bifid glossa with each apicolateral lobe much longer than broad and extending laterally or lateroapically. Most species of the subfamily are large and hairy although the new genus *Mydrosomella* contains a species only 10-12 mm long and with the superficial appearance of some Paracolletini.

Materials and Methods

The characters in the descriptions are numbered for ready comparison between compara-

ble descriptions. Numbers are not useful for comparison between different classificatory levels, e.g., tribe and genus. The same characters and numbers are used for the generic descriptions in the Diphaglossini and Dissoglottini so that comparisons can easily be made among all the genera. Characters italicized in the descriptions are features of a single taxon only, and the alternatives are not repeated for the other taxa. The metasomal terga and sterna are usually referred to as T I, T II, S V, etc. If the propodeum were counted, these would be abdominal terga II, III, and sternum VI.

Collections housing material, and names of curators who kindly lent specimens for study, are as follows:

Balboa— Smithsonian Tropical Research Institute, Balboa, Panamá.—D. W. Roubik.

Berkeley— California Insect Survey, Department of Entomology, University of California.—the late P. D. Hurd, Jr.

Berlin— Museum für Naturkunde der Humboldt-Universität.—F. Koch.

Curitiba— Collection of Padre J. S. Moure, Universidade Federal do Paraná.

Lawrence— Snow Entomological Museum, University of Kansas.

Logan— Bee Biology and Systematics Laboratory, Utah State University, Logan, Utah—T. L. Griswold.

London— British Museum (Natural History).—G. R. Else.

Los Angeles— Natural History Museum of Los Angeles County.—R. R. Snelling.

Mexico— Instituto de Biologia, Universidad Nacional Autonoma de Mexico.

Paris— Museum National d'Histoire Naturelle.—S. Kelner-Pillault.

Tucumán— Instituto de Zoología, Fundación Miguel Lillo.—A. Willink.

Mimicry

A surprising percentage of the species of the subfamily Diphaglossinae resemble superficially unrelated bees occurring in the same regions. There are no biological data to support the view that mimicry is involved. However, I list below some species of Diphaglossinae and in brackets the ordinarily much more common bees that they resemble, followed by comments and the area concerned.

Diphaglossa gayi [Queens of *Bombus dahlbomii* Guéin.] The large size and red color are distinctive (Chile).

Mydrosoma aterrimum [Black species of *Bombus.*] Moure (1945) indicated the similarity to males of black *Bombus.* Large workers would be almost equally similar. The dark wings as well as size and color suggest *Bombus* (Bolivia, Brazil).

Mydrosoma saussurei [*Melipona beecheii* Bennett.] The yellow tergal bands and orange hairs on the anterolateral parts of the thorax suggest this association. As Vachal (1909) noted, this *Mydrosoma* also resembles some species of *Nomia,* but the resemblance is less close, except in abdominal shape, than is that to the *Melipona.* Moreover, *Nomia* is unknown from the region where the *Mydrosoma* has been taken (tropical México).

Mydrosoma opalinum and *brooksi* [Dark *Melipona* such as *M. fasciata* Latreille; possibly some eucerines.] These species look more like diverse groups of bees than the other supposed mimics. The resemblance indicated is strong but perhaps a primitive *Mydrosoma* has this appearance without mimicry (Brazil, Panamá).

Ptiloglossidia fallax [*Thygater analis* (Lepeletier), female, or *Peponapis fervens* (Smith).] Moure (1953) remarked that the female resembled females of *Thygater analis.* I have not seen the female of *P. fallax* but to me the male seems remarkably similar in appearance to *Peponapis fervens* (Argentina).

Cladistics

The lettered variables listed below are those for which polarity (ancestral vs. derived characters) can be determined with reasonable certainty, using Paracolletini (or for most characters, other Colletidae as a whole) as the out-group. The initial statements indicate the apomorphies, numbered in cases where there are two or more levels of apomorphic development. The statement of the plesiomorphic condition for each variable follows in parentheses.

a. Flagellomere 1 longer than scape.

(Flagellomere 1 shorter than scape in most bees.)

b1. Malar space one third as long as eye or more.

b2. Malar space two thirds as long as eye or more. (In most bees the length of the malar space is a small fraction of the length of the eye.)

c. Mandible with two small preapical teeth on upper margin in female. (Mandible with one such tooth.) The presence of two preapical teeth is an unusual and relatively strong character although it appears twice in Figure 1.

d1. Glossa deeply bifid with apicolateral processes attenuate and pointed.

d2. Glossa deeply bifid but apicolateral processes rounded. (Glossa shallowly emarginate, as in other colletids.) The statements above indicate that d2 is a reversion toward the plesiomorphic condition, and an apomorphy relative to d1. If d2 is ancestral to d1, then the d1 condition arose three times assuming that the branching patterns of Figure 1 is correct.

e. Notaulus deep, up to one fourth as long as scutum. (Notaulus short, scarcely impressed, sometimes invisible, as in other bees.)

f. Arolia absent. (Arolia present in nearly all other colletids.)

g. Pre-episternal groove absent below scrobal groove. (Pre-episternal groove strong, complete, as in nearly all other colletids.)

h. Outer hind tibial spur of male not moveable. (This spur moveable in nearly all bees.)

i. Upper parts of second and third hind tarsal segments of female much expanded. (These areas little expanded in other bees shown here and not expanded in most bees.)

j. Base of marginal cell a narrow sinus extending to apex of stigma. (Base of marginal cell relatively broad, not a narrow sinus, in other bees.)

k. Distal parts of wings coarsely papillate. (Distal parts of wings not or weakly papillate in other colletids.)

l. Second submarginal cell very small, almost pointed toward costal margin. (Second submarginal cell of moderate size in other colletids with three submarginal cells.)

m. Stigma greatly reduced, much shorter than and no wider than prestigma. (Stigma longer and broader than prestigma in nearly all other colletids.)

n1. Third submarginal cell equal to or shorter than second.

n2. Third submarginal cell much smaller than second. (Third submarginal cell larger than second in most Paracolletini, etc.) Character n1 appears three times in Figure 1, which shows that this is not a strong character.

o1. Jugal lobe of hind wing almost two thirds length of vannal lobe.

o2. Jugal lobe about half length of vannal.

o3. Jugal lobe less than half length of vannal. (Jugal lobe three fourths length of vannal or more in most Paracolletini and other colletids.) The characters o2 and o3 do not appear in sequence in Figure 1 but are on different branches of the cladogram. Although logically sequential, their distribution may show their independence; that is, o may be a branched variable.

p. Pygidial plate of female narrowed at base. (Pygidial plate of female broadened basally in other bees.)

q. Sternum VII of male without long lateroapical lobes. (Sternum VII with long lateroapical lobes, usually three pairs.) Reduction of the lateroapical lobes occurs in scattered small groups of colletids, two of which are represented in Figure 1. The character is obviously rather weak.

r. Gonostylus nearly as long as to longer than gonocoxite, somewhat expanded at apex. (Gonostylus, at least free part, much shorter than gonocoxite and not expanded at apex in most other colletids.)

s. Penis with pair of longitudinal sclerotic bands on under side from vicinity of volsella nearly to apex. (Penis without such bands, as in other bees.)

Figure 1 was prepared by hand using the variables listed above, showing only the apomorphic and not the plesiomorphic conditions. The lack of apomorphies on the line leading to *Caupolicana* could indicate that that genus is paraphyletic. The same may be true for *Cadeguala,* a rather distinctive genus of only two species, but the polarity of some of its characters is not clear. In view of the similarity of the two species, they are best placed in a single genus even if it proves to be paraphyletic.

Cladograms based on larvae of this

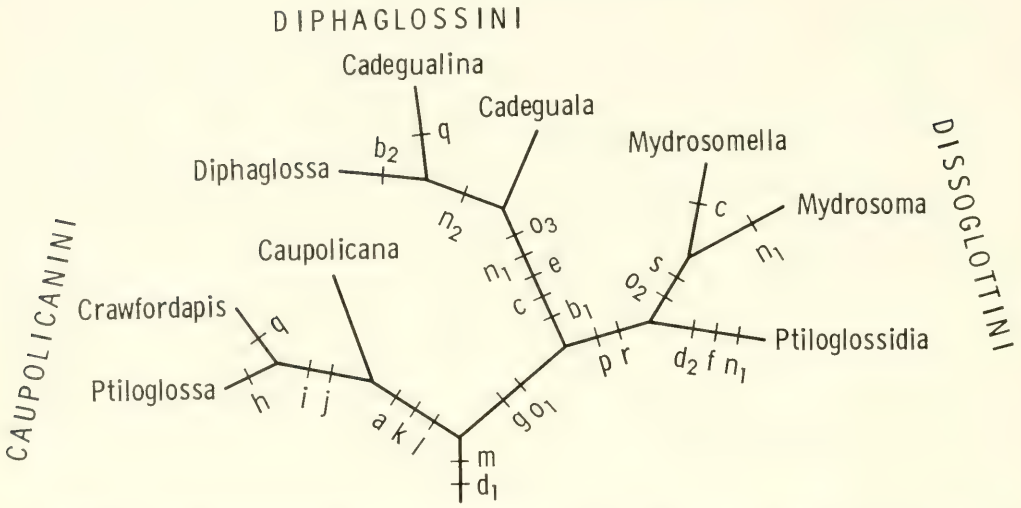


Figure 1. Cladistic relationships of the genera of Diphaglossinae. The letters represent apomorphic characters listed in the section on cladistics; numbers following certain letters represent steps in variables having a series of apomorphic conditions.

group have been prepared by McGinley (1981:285 and in Otis et al., 1982). Larvae of the genera *Caupolicana, Crawfordapis, Ptiloglossa,* and *Cadeguala* (with *Policana*) were included. The 1982 cladogram is in complete agreement with Figure 1 in the relative positions of branching points. For the 1981 paper the same is true of the preferred cladogram *(Crawfordapis* larvae were not included) although in an alternate cladogram *Caupolicana* is the sister group to all the others. Thus the cladogram shown in Figure 1 based on adult characters is strengthened by independently prepared cladograms based on larval characters. Unfortunately no larvae of Dissoglottini are known. A key to the genera of known mature larvae was presented by McGinley (1981) and the larva of *Crawfordapis* was described in Otis et al. (1982).

KEY TO THE TRIBES OF DIPHAGLOSSINAE (Modified from Michener, 1966)

1. Pre-episternal groove complete; flagellomere 1 nearly as long as to longer than scape, much longer than others, petiolate . . . . Caupolicanini
— Pre-episternal groove absent below scrobal groove; flagellomere 1 much shorter than scape, less than twice as long as middle flagellar segments, not or only moderately petiolate. 2
2. Notaulus represented by deep groove in anterior part of mesoscutum; malar space nearly one third as long as eye or longer . . . . . Diphaglossini
— Notaulus weak or absent; malar space short or absent . . Dissoglottini

There is no important new material to add to the account of Caupolicanini published in 1966, except that *Crawfordapis luctuosa* (Smith) has now been found as far south as western Panamá and as far north as the state of Jalisco, México, and its larva and nesting biology have been studied by various authors (Otis et al., 1982; Roubik and Michener, 1985). The other two tribes are treated below.

TRIBE DIPHAGLOSSINI

Diphaglossinae Vachal, 1909:33.

1. Malar space at least 1.5 times as long as basal mandibular width and well over one fourth as long as eye. 2. Mandible of female with two small preapical teeth, thus tridentate, but often worn so that only one preapical tooth is evident. 3. Labrum produced to acute, hairy, medial apical point. 4. Clypeus usually strongly

convex, often protuberant in front of eye by distance as much as eye width (lateral view); apex produced downward well below lower ends of eyes. 5. Vertex seen from front depressed at least laterally, lateral part lower than upper end of eye. 6. Pre-episternal groove absent below scrobal groove. 7. Notaulus deeply impressed in anterior part of scutum. 8. Basitibial plate of female entirely absent or represented by weak carina along posterior margin; hind basitarsus of male half as long as tibia or less. 9. Vein M of forewing meeting or basal to cu-v; second recurrent vein near middle of second submarginal cell. 10. Jugal lobe of hind wing less than half as long as vannal lobe. 11. Pygidial plate of female broadened at base (under T V). 12. Gonostylus not recognizable or if recognized, much shorter than gonocoxite, not expanded distally. 13. Penis not reaching apices of penis valves, without sclerotized rods on under side.

This tribe appeared to be restricted to the Chilean or Araucanian faunal region in 1966, but a genus described below is now known from the Andean area as far north as Venezuela.

The deep notauli are unique among bees and constitute a strong synapomorphy. The long malar areas are also a synapomorphy, although they occur elsewhere in scattered groups of Apoidea.

Key to the Genera of Diphaglossini

1. Malar space about two thirds as long as eye in female, three fourths in male; S III of male with broad, median, apical projection bearing basally directed stiff setae . . . . . *Diphaglossa*
— Malar space about one third as long as eye; S III of male simple 2
2. Third submarginal cell much smaller than second; apex of marginal cell conspicuously obliquely truncate; S VII of male with a small triangular lobe on each side at apex . . . . . *Cadegualina*
— Third submarginal cell about as large as second; apex of marginal cell narrow so that truncation is inconspicuous or absent; S VII of male with three lobes, two of them large, on each side at apex . . . . . *Cadeguala*

Cadegualina new genus

Type species: *Bicornelia andina* Friese, 1925.

This genus probably contains only a single species, hitherto placed in *Bicornelia* (a synonym of *Mydrosoma* in the Dissoglottini), ranging from Bolivia to Venezuela. Superficially it resembles fulvous-haired specimens of *Cadeguala occidentalis* but it is probably more closely related to *Diphaglossa,* as shown by the male genitalia and the reduced third submarginal cell. Characters 3, 4, 5, and 15 in the description below show the similarity of this genus to *Cadeguala* and *Diphaglossa,* and dissimilarity from *Mydrosoma.* Character 13 is especially characteristic of *Cadegualina.*

1. Clypeus of male about as long as broad, damaged in only female available. 2. Flagellomere 1 of male slightly less than half as long as scape, slightly shorter than 2 which is equal to 3; flagellomere 1 of female as long as 2, which is as long as 3; flagellum of male thick, slightly tapering apically. 3. Malar area less than one third as long as eye in female, more than one third as long as eye in male; base of mandible in front of long axis of eye and at angle of 45° (male) or 50° (female) to that axis. 4. Mandible of female with two preapical teeth; postpalpal part of galea about twice as long as broad, much exceeded by maxillary palpus. 5. Notaulus deeply impressed, over one fourth as long as scutum. 6. Basitibial plate of female indicated only by weak ridge along posterior margin of plate area, the whole area covered by short hairs; male without vestige of plate. 7. Femorotibial scopa dense. 8. Legs of male slender, unmodified; hind basitarsus about half as long as tibia. 9. Third submarginal cell much smaller than large second, which receives first recurrent vein at (in type of *sericata)* or before (in lectotype of *andina*) middle. 10. Side of propodeum with abundant plumose hair below very dense hair of upper lateral area. 11. T VII of male rounded, uniformly punctate, without longitudinal ridge or differentiated area. 12. Exposed sterna of male unmodified; S VI with posterior margin thin, rounded. 13. S VII of male without long apicolateral lobes, apical part of sternum flat, distally notched, with short triangular projection on each side. 14. S VIII of male with apical process slender, hairy, not much directed downward, not strongly curved. 15. Male genitalia with gonostylus short, its base (or adjacent gonocoxal parts) on under side expanded and with brushes of hair.

Cadegualina andina (Friese) new combination

Figs. 17-20, 62, 63

Bicornelia andina Friese, 1925:12 (lectotype male, Berlin); Snelling, 1980:3.

?Bicornelia sericata Friese, 1925:11 (type female, Berlin).

The above synonymy, which was also suggested by Friese (1925), is questionable because the specimen on which the name *sericata* is based is a female labelled Guayaquil, Ecuador, while the name *andina* is based on two males from "Sierra Parime", Venezuela, and one male from Tarata (Cochabamba), Bolivia. The two Venezuelan specimens are in the Berlin museum but the Bolivian specimen cannot be found there according to Dr. Frank Koch. In characters not likely to vary sexually, e.g., wing venation, the males from Venezuela and female from Ecuador are similar.

Snelling (1980) restricted the type locality of *Bicornelia andina* to Sierra Parime, Venezuela. The labels actually read "Venezuela/St. Parime/1897." The locality is almost certainly not the remote Sierra Parima on the Venezuela-Brazilian border, but the modern equivalent of St. Parime is unknown to me, as is the reason for Friese's rendering of "St." as Sierra. I have labelled and here designate one of the two male specimens from Venezuela as lectotype.

Genus *Cadeguala* Reed

Cadeguala Reed, 1892:234. Type species: *Colletes chilensis* Spinola, 1851 (= *Colletes occidentalis* Haliday, 1836) by designation of Sandhouse, 1943:532.

Policana Friese, 1910:651 (new synonym). Type species: *Colletes herbsti* Friese, 1910 (= *Colletes albopilosus* Spinola, 1851) by designation of Sandhouse, 1943:589.

This genus differs from *Cadegualina* and *Diphaglossa* in characters 9 and 10, from *Cadegualina* especially in character 13, and from *Diphaglossa* in characters 1, 3, etc. Like *Diphaglossa* but unlike *Cadegualina* and most dissoglottines, *Cadeguala* has the marginal cell narrow, so that at the apex the cell seems narrowly rounded or obscurely obliquely truncate. *Cadegualina* and the dissoglottines have the marginal cell broader so that the apical, oblique truncation is easily recognizable.

1. Clypeus broader than long. 2. Flagellomere 1 of male less than *(albopilosa)* to more than *(occidentalis)* half as long as scape, shorter than or longer than 2 which is as long as 3; flagellomere 1 of female longer or shorter than 2 and 3 together; flagellum of male of approximately uniform thickness. 3. Malar space less than (female) or more than (male) one third as long as eye, directed forward so that in male, mandibular base is entirely in front of longitudinal median axis of eye and in female it is largely so; mandibular base at 45°-55° to that axis; mandible directed somewhat forward in male, not in female. 4. Mandible of female with two preapical teeth; postpalpal part of galea over three times as long as broad, nearly attaining *(albopilosa)* or exceeding *(occidentalis)* apex of maxillary palpus. 5. Notaulus deeply impressed, nearly one fourth as long as scutum. 6. Basitibial plate in female absent, posterior margin represented by weak ridge, whole area covered by dense short hair; in male carina represents posterior margin. 7. Femorotibial scopa dense. 8. Legs of male slender, unmodified *(albopilosa)* or posterior tibia, on posterior margin apically, produced as short lamella *(occidentalis);* hind basitarsus less than half as long as tibia. 9. Third submarginal cell subequal to or slightly smaller than second which receives first recurrent vein near middle. 10. Sides of propodeum of female with only sparse and relatively short hairs, beneath the longer, denser but not extensive hairs of upper lateral area. 11. T VII of male rounded *(albopilosa)* or truncated *(occidentalis)* apically, if rounded with median, basal, impunctate and hairless area, sometimes slightly elevated and extending posteriorly as weak ridge, if truncated with median bare zone broadened posteriorly to width of truncation. 12. Sterna of male unmodified, S VI with margin convex between posterior lateral teeth *(albopilosa)* or appearing concave (but concavity largely filled with transparent cuticle) between weak posterior lateral angles *(occidentalis).* 13. S VII of male with three pairs of apical lateral lobes, all with at least some hair. 14. S VIII of male with apical process robust, directed or curved somewhat downward, not especially long, with weak preapical protuberance. 15. Gonostylus (if present) much shorter than gonocoxite, without dense brushes in region of its base.

This genus probably contains only two species. A generic name is available for

each, and the species could be placed in separate subgenera, but the differences are not great, even though each species has been given generic status (Moure, 1945, 1953). Both are well known in Chile and range into Argentina, one of them also into Bolivia.

Key to the Species of *Cadeguala*

1. Flagellomere 1 more than half as long as scape, in female over twice as long as 2 (measured on shortest side), in male about 1.5 times as long as 2; posterior tibia of male at apex produced posteriorly as short lamella; sternum VI of male with posterior margin broadly emarginate between lateroapical rounded angles, the emargination largely filled with thin transparent cuticle so that the true margin is scarcely emarginate; sternum VII of male with three apical lobes on each side, basal and distal ones broad and partly hairy, median one slender and hairy only apically. . . . *occidentalis*
— Flagellomere 1 less than half as long as scape, in female about one fourth longer than 2, in male somewhat shorter than 2; posterior tibia of male slender, simple; sternum VI of male with posterior margin convex medially between lateroapical angles; sternum VII of male with three apical lobes on each side, basal one long, curved, nearly hairless and linear, others broad and hairy . . . . . *albopilosa*

Cadeguala occidentalis (Haliday)

Figs.2, 21-25, 64

Colletes occidentalis Haliday, 1836:322.
Colletes chilensis Spinola, 1851:220.
Colletes nigroventris Spinola, 1851:221.
Colletes tetra Spinola, 1851:221.
Colletes nigriventris Smith, 1853:4.
Cadeguala chilensis, nigroventris and *tetra:* Reed, 1892:233.
Colletes smithii Dalla Torre, 1896:44 (new name for *C. nigriventris* Smith, 1853, not *C. nigroventris* Spinola, 1851).
Diphaglossa occidentalis and *nigroventris:* Vachal, 1909:54.
Colletes (Policana) chilensis and *tetra:* Friese, 1910:651.
Colletes (Cadeguala) occidentalis and var. *nigriventris:* Herbst, 1917a:293.
Cadeguala occidentalis: Herbst, 1917b:283.
Diphaglossa occidentalis and *tetra:* Herbst, 1921: 109, 110.
Policana occidentalis: Herbst, 1923, 27:76.

This large species, known from Chile, western Argentina, and Bolivia, is highly variable. The above synonymy places the form with the wholly black female *(tetra)* in the same species as the common form with fulvous pubescence, as has been suggested by various authors, even Spinola (1851). Wholly black males are unknown but among males with fulvous hair on the head and thorax, there are specimens with the metasomal pubescence fulvous, others with it mostly black. Genitalia and sterna, as well as other structures, seem to be the same in all forms. There is an indication in material in the Snow Entomological Museum that black females are most abundant in the northern part of the range of the species. Field study is desirable to determine the status of the color forms.

I have not examined the relevant type specimens; the above synonymy is based on descriptions and synonymies indicated by the authors listed. An effort has been made to show the history of the names, i.e., the generic associations, but not every subsequent reference.

Cadeguala albopilosa (Spinola) new combination

Figs.26-30, 67

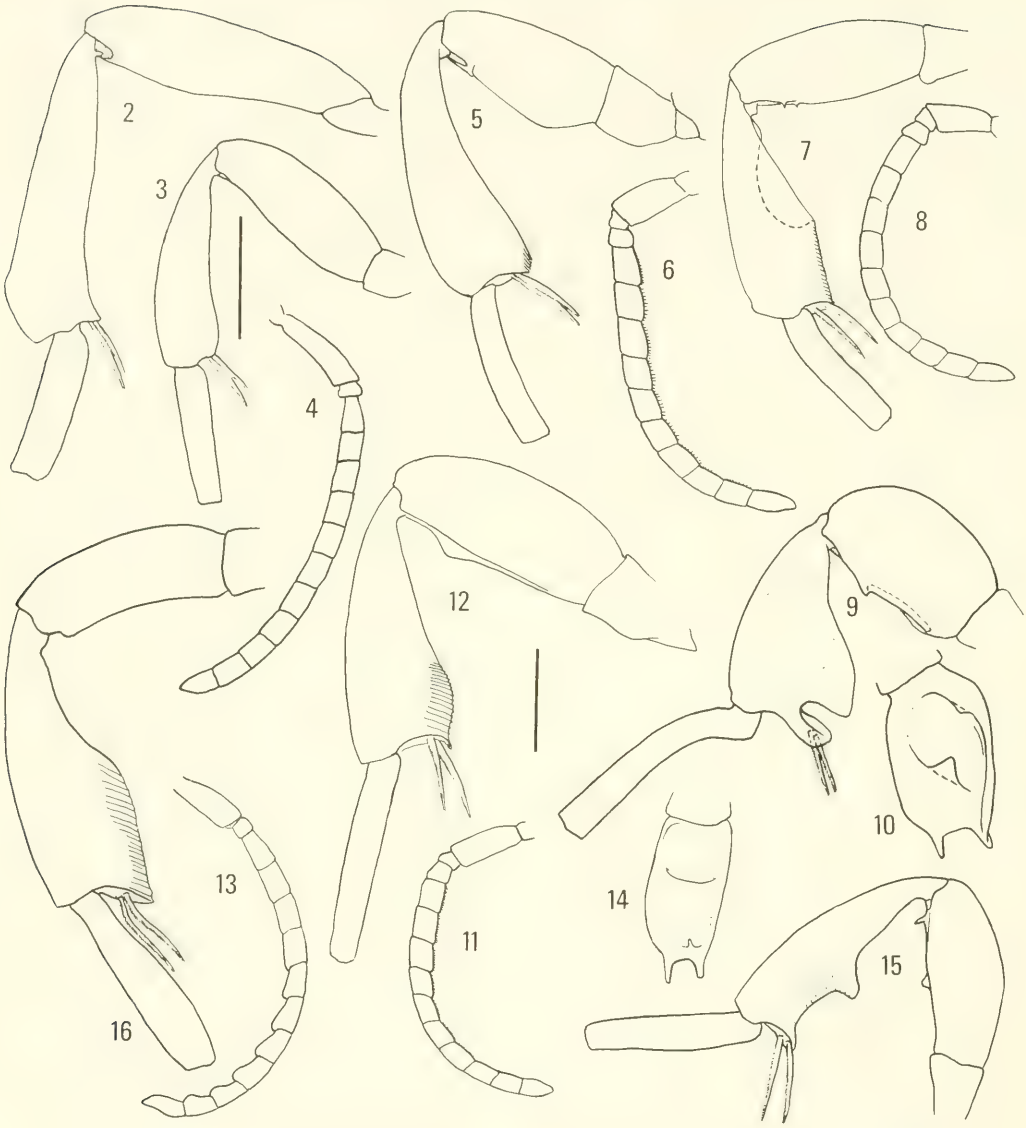
Colletes albopilosa Spinola, 1851:222.
Lonchopria albopilosa: Vachal, 1909:54.
Colletes (Policana) herbsti Friese, 1910:651.
Colletes (Cadeguala) albopilosus: Herbst, 1917b: 294.
Policana herbsti: Herbst, 1923:76.
Policana albopilosa: Moure, 1953:61.

The above synonymy is based on descriptions and other authors' conclusions, especially those of Moure (1953).

Genus *Diphaglossa* Spinola

Diphaglossa Spinola, 1851:168. Type species: *Diphaglossa gayi* Spinola, 1851 (monobasic).

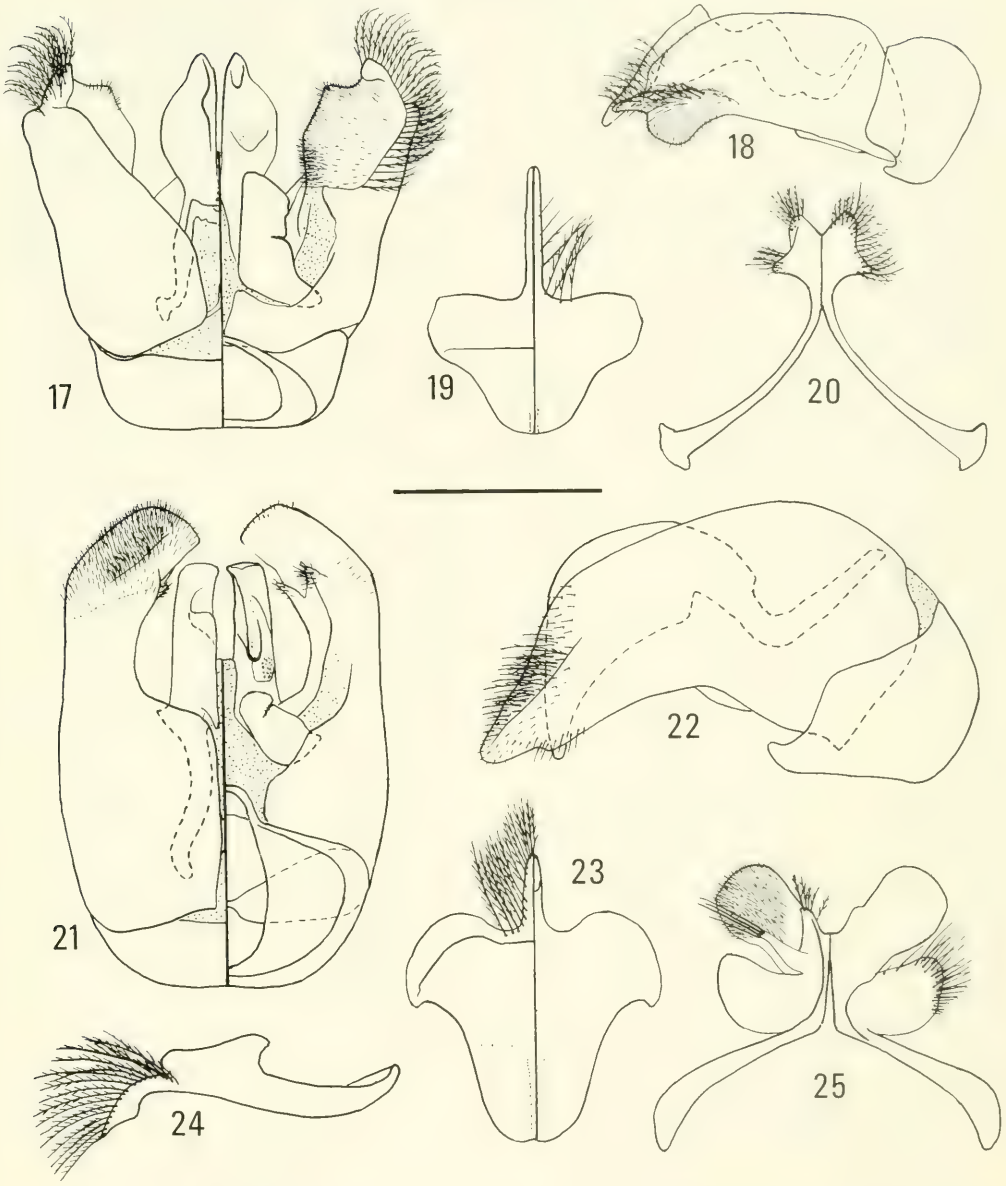
This genus contains a single Chilean



Figures 2-16. Outer views of hind legs, antennae, and under surfaces of hind femora of males. Scale lines = 1 mm; one is for Figs. 2 and 3 only, the other for all others. 2, *Cadeguala occidentalis;* 3, 4, *Mydrosomella gaullei;* 5, 6, *Mydrosoma opalinum;* 7, 8, *M. brooksi;* 9-11, *M. saussurei;* 12, 13, *M. longitarse;* 14, 15, *M. inusitatum;* 16, *M. serratum.*

species. It is large (17-19 mm long) and covered with orange-red hair. Characters 1, 3, and 12 are especially distinctive. The slender marginal cell is discussed under *Cadeguala.*

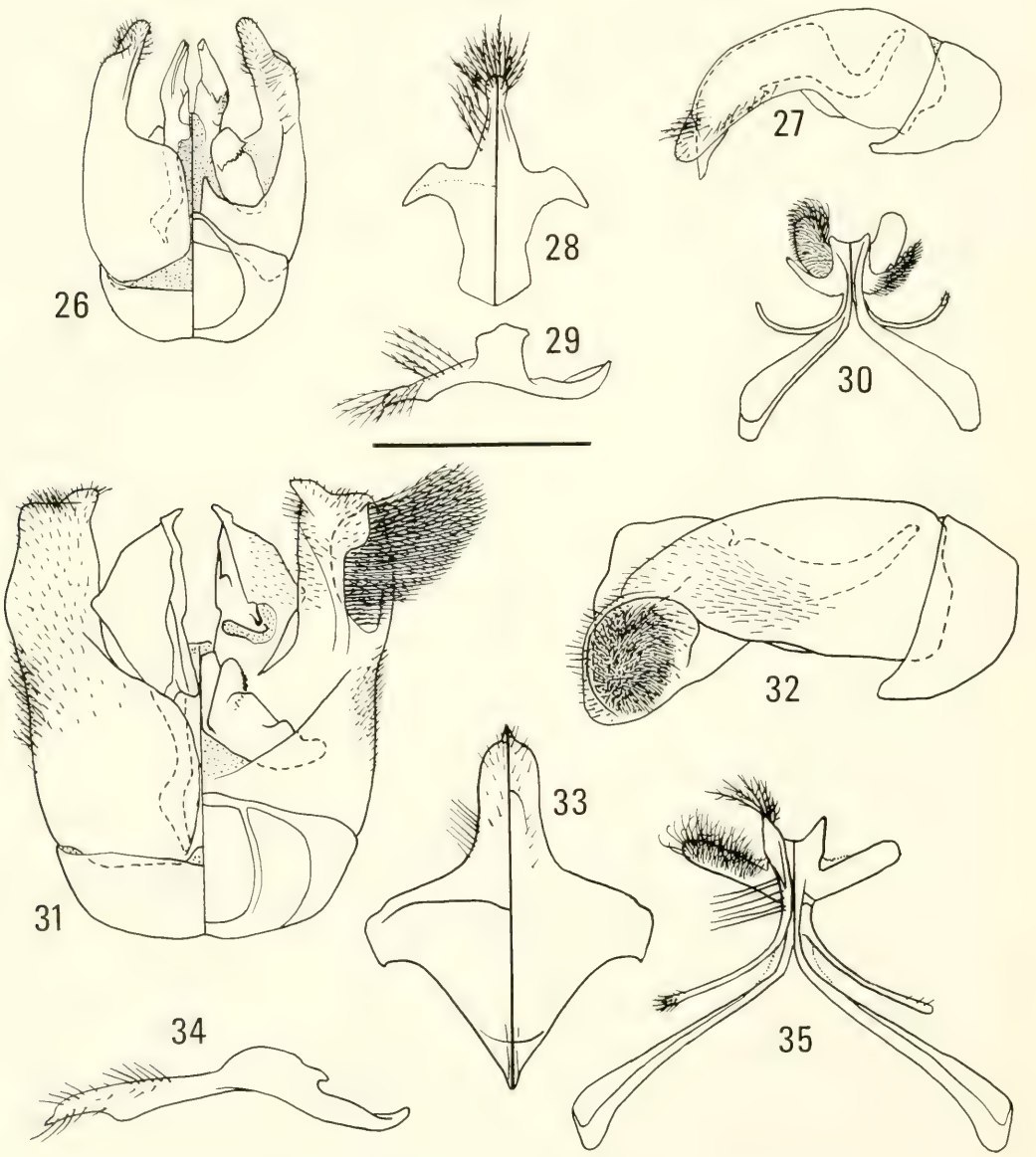
1. Clypeus longer than broad; labrum and parts of mandible and clypeus yellowish in male; *inner orbits diverging below, only slightly so in male.* 2. Flagellomere 1 of male half as long as scape, nearly as long as 2 which is nearly as long as 3; flagellomere 1 of female about 1.5 times as long as 2 which is somewhat shorter than 3; flagellum of male slightly tapering, distal segments smaller in diameter than basal ones. 3. Malar area enormous, two thirds as long as eye in female, three fourths in male, directed forward so that although mandible is not directed anteriorly in female and only moderately so in male, mandibular base is entirely far anterior to longitudinal median axis of eye; mandibular



Figures 17-25. Male genitalia (dorsal view on left, ventral on right); side view of same; eighth and seventh metasomal sterna, the latter recognized by diverging basal apodemes (dorsal view on left, ventral on right); and side view of eighth sternum when it is not rather flat. Scale line = 1 mm. 17-20, *Cadegualina andina;* 21-25, *Cadeguala occidentalis.*

base at angle of about 45° to that axis. 4. Mandible of female with two preapical teeth; postpalpal part of galea over three times as long as broad, maxillary palpus reaching galeal apex. 5. Notaulus deeply impressed, nearly one fourth as long as scutum. 6. Basitibial plate of female absent, area covered by dense hairs; basitibial plate of male indicated by carina along posterior margin. 7. Femorotibial scopa dense. 8. Legs of male unmodified, slender, hind basitarsus about half as long as tibia, somewhat flattened and slightly curved. 9. Third submarginal cell much smaller than second which is large and receives first recurrent

vein near middle. 10. Side of propodeum of female with abundant plumose hair, that of upper lateral part not much denser. 11. T VII of male rounded, with small median apical angle and longitudinal median sparsely haired zone which is elevated basally, apically sparsely haired zone broadened but not elevated. 12. S III of male with median, apical, truncate projection densely covered with anteriorly directed coarse hairs; S V with apex broadly emarginate; S VI appearing subtruncate with preapical median densely hairy thickening or convexity, behind which is convex transparent margin. 13. S VII of male with three pairs of apical lateral lobes, all hairy, distal ones small, basal ones straplike. 14. S VIII of male with apical process robust, curved downward, with basal protuberance on under side. 15. Gonostylus (if present) with projecting part minute, base (or adjacent parts of gonocoxite) with large brush of dense hair arising in deep pocket on outer surface.



Figures 26-35. Explanation as for 17-25. 26-30, *Cadeguala albopilosa;* 31-35, *Diphaglossa gayi.*

Diphaglossa gayi Spinola

Figs. 31-35, 65

Diphaglossa gayi Spinola, 1851:170.

This well known species is the only member of its genus.

Tribe Dissoglottini

Dissoglottini Moure, 1945:142; 1953:73.
Ptiloglossidiini Moure, 1953:71; Michener, 1966:719 (new synonym).
Mydrosomini Michener, 1966:719 (new synonym).

The tribal name Dissoglottini has priority and must be used according to Article 40 of the International Code of Zoological Nomenclature, even though *Dissoglotta* is here considered a synonym of *Mydrosoma*. Ptiloglossidiini is a subjective synonym; I think it does not warrant recognition at the tribal level.

1. Malar space shorter than basal width of mandible, sometimes virtually absent, its length only small fraction of length of eye. 2. Mandible of female with a single preapical tooth (apex of pollex), thus bidentate except in *Mydrosomella* which has a third small tooth. 3. Labrum produced to an obtuse, hairy median apical angle. 4. Clypeus usually rather flat, not strongly protuberant, apex produced downward not over about one fourth its length below lower ends of eyes. 5. Vertex flat or convex seen from front, lateral part not much if any depressed. 6. Pre-episternal groove absent below scrobal groove. 7. Notaulus absent or nearly so. 8. Basitibial plate of female invisible because of hair covering, but complete or represented at least by elevated area without sharp margin or by ridge or carina along posterior margin of plate area (not seen in *Ptiloglossidia);* hind basitarsus of male more than half as long as tibia. 9. Vein M distal to cu-v of forewing; second recurrent vein before middle of second submarginal cell. 10. Jugal lobe slightly less than to slightly more than half as long as vannal lobe of hind wing (in *Ptiloglossidia* jugal lobe almost two thirds as long as vannal). 11. Pygidial plate of female rather broadly rounded, narrowed at base (under T V) instead of broadened as in most bees (not examined in *Ptiloglossidia).* 12. Gonostylus about as long as gonocoxite, usually expanded distally (in *Mydrosomella* not differentiated and scarcely expanded). 13. Penis variable.

This tribe is found in tropical and south temperate America from Mexico to Argentina but appears to be absent from Chile where the Diphaglossini is abundant. All the species are rare, known from single or very few specimens.

Key to the Genera of Dissoglottini

1. Arolia absent; glossa moderately bifid, apicolateral lobes longer than wide but not attenuate and pointed . . . . . *Ptiloglossidia*
— Arolia present; glossa strongly bifid, its apicolateral lobes attenuate, pointed 2
2. Second submarginal cell smaller than third; basitibial plate of female complete, margined (although hidden by hairs) . . . . . *Mydrosomella*
— Second submarginal cell larger than or rarely the same size as third; basitibial plate of female at most a slightly elevated area with an elevated posterior margin. . . *Mydrosoma*

Genus *Ptiloglossidia* Moure

Ptiloglossidia Moure, 1953:73. Type species: *Ptiloglossidia fallax* Moure, 1953, by original designation and monotypy.

This genus contains a single species, easily distinguished from all others by the lack of arolia, but differing also in numerous other features including the only moderately bifid glossa which is thus intermediate between that of most Colletinae and the deeply bifid and attenuately produced glossa of other Diphaglossinae. I have not seen the female; hence all the information on the female in the following description is based on Moure's (1953) description.

1. Clypeus somewhat broader than long; *integument of head of male yellow, female with yellow on labrum, mandible, and genal area.* 2. Flagellomere 1 of male about two thirds as long as scape, 1.5 times as long as 2 which is slightly shorter than 3; flagellomere 1 of female as long as 2 and 3 together; flagellum of male of uniform thickness. 3. Malar area short; mandible directed somewhat anteriorly, base mostly in front of longitudinal median axis of eye, at about 70° to that axis. 4. Mandible of female with one preapical tooth; postpalpal part of galea about twice as long as broad, much exceeded by maxillary palpus; *glossa moderately*

bifid, apicolateral lobes longer than broad, not attenuate as in other genera. 5. Notaulus scarcely evident. 6. *Arolia absent;* basitibial plate of female not described, of male absent. 7. "Femoral-tibial scopa less developed than in other members of the subfamily" (Moure, 1953); this statement would not include *Mydrosomella* which was unknown to Moure. 8. Legs of male unmodified, slender; hind basitarsus more than half as long as tibia. 9. Third submarginal cell as long as and somewhat larger in area than second, which receives first recurrent vein before middle. 10. (Female not seen.) 11. T VII of male rounded, uniformly punctate, without longitudinal median ridge or differentiated area. 12. Exposed sterna of male unmodified but with very long hair; S VI with posterior margin thin, rounded. 13. S VII of male with three pairs of apical lateral lobes, all with hairs, the dorsoapical lobes small. 14. S VIII of male with apical process slender, tapering, hairy, curved somewhat downward. 15. Male genitalia with partly differentiated gonostylus about as long as gonocoxite, slightly expanded apically; penis not quite reaching apex of penis valve, without sclerotic bands on under side.

The following is the only known species.

Ptiloglossidia fallax Moure

Figs. 36-40, 68, 73

Ptiloglossidia fallax Moure, 1953:74 (cotypes, 1 male, 1 female, Curitiba, not available for study; 1 male, Tucumán).

This species, known only from the province of Salta, Argentina, was described fully by Moure. There were three cotypes; since Moure described the female first, presumably the female cotype in his collection should be designated as the lectotype. The cotypes were from Salta (presumably the city) and from Coronel Moldes. Two males are from Campo Durán, 51 km NNE of Tartagál, 500 m altitude, March 16, 1984 (R.B.Roberts, Rutgers Univ.).

Mydrosomella new genus

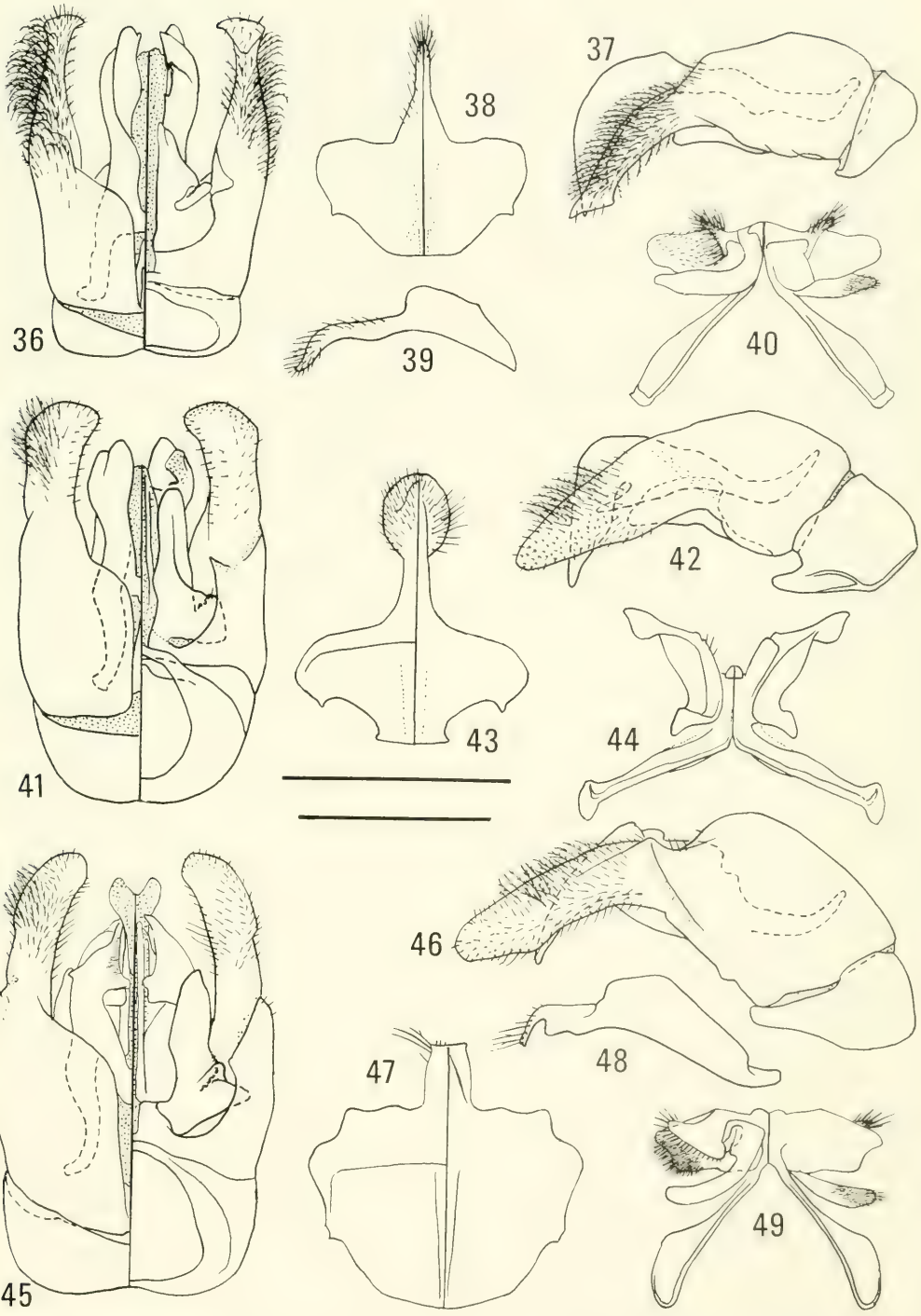
Type species: *Diphaglossa ? gaullei* Vachal, 1904.

This genus contains a single Argentine species, the smallest of the subfamily Diphaglossinae; it looks superficially like a paracolletine (subfamily Colletinae) rather than like the usually large, long-haired and impressive species of Diphaglossinae. (Females of *Mydrosoma bohartorum, sinaloa, serrata* and *inusitata* also have a rather "ordinary" or paracolletine appearance.) This aspect is partly a result of the relatively short and not especially dense pubescence of *Mydrosomella,* a feature that distinguishes this genus from most other Diphaglossinae.

1. Clypeus about twice as wide as long in male, even wider in female. 2. Flagellomere 1 of male slightly longer than 2, of female nearly as long as 2 plus 3; flagellum of male of uniform width. 3. Malar area very short, mandible directed anteriorly so that base is nearly all in front of median axis of eye and at an angle of about 45° to that axis. 4. Mandible of female with two small preapical teeth (only one visible in worn mandible); postpalpal part of galea over twice as long as broad, exceeding small maxillary palpus. 5. Notaulus short, weakly depressed; *scutoscutellar suture in a deep fossa, front margin of scutellum nearly vertical.* 6. Basitibial plate of female defined anteriorly and posteriorly by carinae, distally by being slightly elevated; plate hidden by short hairs; plate of male absent. 7. Femoral scopa consisting of relatively few large, long hairs arising along anterior margin of femur and extending down and curving posteriorly to enclose femoral corbicula. 8. Legs of male unmodified; hind basitarsus a little more than half as long as tibia. 9. Third submarginal cell larger and longer than second, which receives first recurrent vein before middle. 10. Side of propodeum of female with only sparse hairs in contrast to long, dense dorsolateral hairs. 11. T VII of male rounded, with longitudinal median hairless ridge. 12. Exposed sterna of male unmodified; S VI with posterior margin thin, rounded between lateral shoulders. 13. S VII of male with two pairs of lobes, both hairless. 14. S VIII of male with apical process straight, distal part of process expanded. 15. Male genitalia with weakly differentiated gonostylus longer than gonocoxite; penis with pair of weakly sclerotized bands along under side.

Although this genus exhibits various apomorphies such as the deep scutoscutellar groove and probably characters 4 and 14, it is the plesiomorphies that are noteworthy, e.g., characters 6, 7, 9, and 10. The genus thus may suggest in some ways what the ancestral Diphaglossinae were like.

Etymology: Mydrosoma plus the suffix *-ella,* meaning small and *Mydrosoma*-like.



Figures 36-49. Explanation as for 17-25; the long scale line is for Figs. 41-44, the shorter line for the others. 36-40, *Ptiloglossidia fallax;* 41-44, *Mydrosomella gaullei;* 45-49, *Mydrosoma saussurei.*

Mydrosomella gaullei (Vachal) new combination

Figs. 3, 4, 41-44, 69, 74, 75

Diphaglossa ? gaullei Vachal, 1904:23 (type female, Paris).

Male: 1. Length 10 mm; forewing length 7 mm. 2. Inner orbits slightly converging below except upper extremities which converge above. 3. Interantennal distance slightly greater than antennocular distance. 4. Interocellar distance over 2.5 ocellar diameters, equal to ocellocular distance and much greater than ocelloccipital distance which is less than 1.5 ocellar diameters. 5. Distance from median to lateral ocellus about equal to diameter of median ocellus (which is larger than lateral). 6. Malar space almost half as long as broad, about half as long as flagellar diameter. 7. Labrum shining, flat except along free margin which is convex, with irregular coarse longitudinal rugae except on free margin. 8. Flagellomere 1 nearly twice as long as broad, longer than either 2 or 3 which are subequal and slightly less than 1.5 times as long as broad. 9. Flagellomeres 2-10 cylindrical, of uniform diameter, i.e., flagellum not tapering apically, middle segments a little over 1.5 times as long as wide. 10. Second recurrent vein basal to third transverse cubital. 11-13. Legs not conspicuously modified, hind femur about three times as long as wide, hind tibia nearly four times as long as wide with large, shining, smooth, almost hairless area on apical half of outer surface. 14. Hind basitarsus a little more than half as long as tibia, straight and parallel-sided, about as long as remaining tarsal segments. 15. Exposed sterna unmodified. 16, 17. Head with fine roughening between punctures strong so that head is dull, lower parts of clypeus and paraocular areas slightly shining; lower third of clypeus with irregular large depressions and without punctures except laterally; punctures small and rather close on lower paraocular area and side of clypeus, elsewhere small, inconspicuous, and widely separated, absent in foveal area which is otherwise not defined and which extends up between lateral ocellus and eye. 18. Thorax with small, widely separated punctures (or hair bases), absent on posterior part of disc of scutum, on strongly minutely roughened ground, somewhat more shiny than most of head; punctures closer along lateral margins of scutum, posterior margin of scutellum, metanotum and upper lateral areas of propodeum; propodeal triangle not punctate, minutely roughened like rest of thorax. 19. Metasomal terga shining with minute roughening finer than on thorax; punctures of T I-IV small and widely separated, coarser on T V and especially on T VI and VII, on the last rather close except for longitudinal, median, convex, impunctate zone; punctures finer on broad, feebly depressed posterior margins of T I-VI, T I-V with narrow premarginal zone of fine close punctures from which white hairs of fasciae arise, margins proper narrowly impunctate. 20. Sterna with surfaces similar to those of terga, S II-V with preapical zones of strong punctures basal to which punctures are very sparse and distal to which are impunctate apical zones much broader than those of terga. 21. Integument black, distal half of mandible and small tarsal segments rufescent; tegula and upper side of flagellum brownish black; under side of flagellum light brown; tibial spurs brown, yellowish apically; posterior margins of terga and entire T VII brownish black, margins of S I-III and entire S VI dark brown, translucent. 22. Wings light grayish brown, veins and stigma dark brown except vein R of forewing which is black. 23. Pubescence of head white, rufescent on labral margin, most of hairs on vertex dusky; pubescence of thorax and legs white, largely blackish on discs of scutum and scutellum (but margins of these sclerites with white) and upper half of pleural region; black hairs also intermixed on upper part of side of propodeum; hairs of small segments of tarsi yellowish orange, on inner sides of basitarsi and tibiae orange, somewhat dusky on mid and hind basitarsi; T I with long white hairs similar to those of thorax, remaining terga with much shorter, suberect hair, white on T II, blackish on others except for some white hairs on ventrolateral parts of terga; T I-V with narrow apical bands of decumbent, white hair; S I-V with long whitish hairs arising from preapical zones of punctures.

Female. 1f. Length 11-12 mm; forewing length 8-8.5 mm. 2f. As in male. 3f. As in male or interantennal distance subequal to antennocular distance. 4f. Interocellar distance little over two ocellar diameters, shorter than ocellocular distance, much greater than ocelloccipital distance which is little over an ocellar diameter. 5f. Distance from median to lateral ocellus less than diameter of median ocellus. 6f. Malar space less than or about one third as long as broad, less than or about half as long as flagellar diameter. 7f. As in male. 8f. As in male but second and third segments slightly broader than long. 9f. Flagellum slightly thicker preapically than near base, middle segments slightly broader than long. 10f. As in male. 14f. Hind basitarsus on outer surface shining, scarcely concave, hairs not dense. 16f, 17f. As in

male but lower third of clypeus strongly shining; punctures of sides of clypeus and lower paraocular area widely separated as on most of head; supraclypeal area impunctate except upper and lateral parts; genal area with broad shiny zone. 18f. As in male. 19f. As in male (T VII absent of course); the broad margins with finer punctures and also the premarginal zones of fine punctures are on T I-IV only. 20f. Sterna with punctures coarser than those of terga, dense in premarginal zones of S I-V and on whole of S VI; apical impunctate margins of sterna narrow and hidden by long hairs. 21f. As in male but tegula and upper surface of flagellum black; tibial spurs dark brown; terga without brownish; sterna dark red brown to blackish. 22f. As in male. 23f. Pubescence blackish except as follows: dusky rufescent on mandible, labral apex and clypeal margin; hairs of face below ocelli white with scattered black intermixture, especially on disc of clypeus; hairs of anterior part of scutum and of scutal margins, margins of scutellum, and entire metanotum white, white intermixed among black on much of scutum; posterior lobe of pronotum with bright white hairs posteriorly, many of hairs of pleura, sides of propodeum, and legs dusky rather than black; scopal hairs of anterior margins of hind tibia and basitarsus white; hairs of tarsi largely dusky or dusky orange on outer surfaces, on inner sides of tibiae and tarsi orange or dusky orange to blackish. T I with long white hairs, other terga with hairs short, black except for narrow apical bands of white on T I-IV; prepygidial and pygidial fimbriae black; hairs of sterna yellowish or brownish white, dusky on S VI, blackish hairs intermixed basal to fringe of S II of type.

This species has hitherto been known only from the single female holotype from Tucumán, Argentina [Paris]. The specimen bears no other data; the label reads only "Tucuman, Rep.Arg." It is not clear whether it is the city or the province of Tucumán that is intended, but the former is likely to judge by specific localities cited for other species collected by Girard (Vachal, 1904). The specimen is badly worn, and only one preapical mandibular tooth is evident. Additional specimens are a female and a male, slightly smaller than the type, from Tigre, Buenos Aires Prov., Argentina, 3/10 November, 1956 (collector unknown) [Lawrence].

Genus *Mydrosoma* Smith

Apista Smith, 1862:148 (not Hübner, 1816). Type species: *Apista opalina* Smith, 1862, monobasic.

Mydrosoma Smith, 1879:5. Type species: *Mydrosoma metallicum* Smith, 1879 (=*Apista opalina* Smith, 1862), monobasic.

Bicornelia Friese, 1899:239 (new synonym). Type species: *Bicornelia serrata* Friese, 1899, monobasic.

Madrosoma Ashmead, 1899:94 (*lapsus* for *Mydrosoma*).

Egapista Cockerell, 1904:357 (new name for *Apista*). Type species: *Apista opalina* Smith, 1862, autobasic.

Dissoglotta Moure, 1945:144 (new synonym). Type species: *Dissoglotta stenoceratina* Moure, 1945, original designation and monobasic.

This genus of moderate sized to large bees differs from its relatives by characters 3, 6, 9, the presence of arolia, etc.

1. Clypeus approximately twice as broad as long in female, somewhat longer in male; head without yellow or in male of *longitarse, serratum,* and *inusitatum* partly or wholly yellow. 2. Flagellomere 1 of male less than half as long as scape (scarcely so in *longitarse*), shorter than 2 (scarcely so in *longitarse*); flagellum of male tapering so that distal segments, at least in one view, are narrower than basal ones (if processes are omitted on those with serrate antennae). 3. Malar area short, up to three fourths as long as wide; mandible scarcely directed anteriorly, base partly behind longitudinal median axis of eye, at about 80 to that axis. 4. Mandible of female with one preapical tooth. 5. Notaulus scarcely evident. 6. Basitibial plate of female at most indicated by a slightly elevated area with a small ridge on posterior (not distal) side, that of male absent. 7. Femorotibial scopa of dense hairs (less so in *serratum* and *inusitatum*). 8. At least hind tibia of male somewhat enlarged (scarcely so in *opalinum* and *bohartorum*); hind femur and basitarsus sometimes also modified; hind basitarsus of male more than half as long as tibia. 9. Second submarginal cell about equal to third (in *opalinum*) or usually larger than third, receiving first recurrent vein well before middle or in *sinaloa,* interstitial with first transverse cubital. 10. Side of propodeum of female with many coarsely plumose hairs below dorsolateral area of extremely dense, long hairs. 11. T VII of male rounded, distal part with longitudinal median convexity which is more sparsely punctate than rest of tergum, or partly impunctate.

12. Exposed sterna of male unmodified or S V or S VI with small median tubercle; S V with apex broadly emarginate and with apicolateral tufts of dense hair in *serratum* and *inusitatum;* S VI with posterior margin thin and rounded or subtruncate. 13. S VII of male with three pairs of apicolateral lobes, basal one slender and overlying apodeme, distal ones superimposed, one above the other, and sometimes united along posterior margins, all lobes with hairs. 14. S VIII of male with apical process slender, directed ventroapically, often hooked ventrad, with preapical ventral protuberance. 15. Male genitalia with differentiated gonostylus at least as long as gonocoxite, usually expanded apically; penis usually attaining or exceeding apex of penis valve, with pair of longitudinal sclerotic bands on under side extending from vicinity of volsella nearly to apex of penis.

This genus contains several superficially diverse looking species. If one ignores the modifications of the hind legs and antennae of some of the males, however, the species are morphologically similar and appear to form a unified genus. *Bicornelia* was originally proposed for *M. serratum,* a species with the male antennal flagellum strongly serrate, a character shared with *M. inusitatum.* These two species also have a spine on the mid trochanter of the male, and a pair of small convexities on T VI of the male, characters not shared with other species. However, *M. longitarse* also has serrate antennae but lacks the trochanteral spine and the convexities on S VI are adjacent to one another and perhaps not homologous to those of *M. serratum* and *inusitatum.* The under sides of the hind femora of males have perhaps homologous modifications in *M. inusitatum* and *saussurei,* with a similar distal structure also in *M. brooksi* and *opalinum.* The under side of the male hind tibia has apical and preapical projections, perhaps homologous, in *M. inusitatum* and *saussurei.* The hind basitarsus is unusually long, nearly as long as or longer than the tibia, in *M. longitarse* and *saussurei.* Flagellomere 1 of the male is considerably longer than broad in *M. serratum* and *longitarse,* shorter in the others. In *M. bohartorum* the legs and exposed sterna are simple. Considering all the combinations of species and characters listed above, and others based on other characters, the recognition of subgenera does not seem justified. One could separate *Bicornelia* as a subgenus, but *M. longitarse* bridges the gap between it and other *Mydrosoma* in male characters. Moreover, the female of *M. bohartorum,* a species with simple legs and antennae in the male, is very similar to that of *M. inusitatum* and *serratum,* whose males have the elaborately modified antennae and legs characteristic of *Bicornelia.* See also the discussion under *M. inusitatum.*

M. opalinum and *brooksi* constitute a group of closely related species, as indicated in the description of *brooksi.* The short, transverse basal lamella on S V of the male is an obvious synapomorphy of this pair of species. *M. inusitatum* and *serratum* also are closely related, with many synapomorphies, as detailed in the discussion of the former. *M. longitarse* shares some apomorphic characters such as the serrate male flagellum and yellow on the clypeus with the *inusitatum-serratum* group, but also has numerous presumably plesiomorphic features such as the form of S VII of the male that agree with the *opalinum-brooksi* group and with *M. saussurei.* The last mentioned and *M. aterrimum* are apparently isolated among known species, having no close relatives (unless the male of *aterrimum,* when it is restudied, shows relationships that are not now apparent).

KEY TO THE SPECIES OF MYDROSOMA

1. Males 2
— Females 9
2. Distal half or more of flagellum strongly serrate; face with yellow (at least apical margin of clypeus yellow) 3
— Flagellum not serrate; face without yellow 5
3. Flagellomere 1 less than half as long as 2; hind tibia with large postmedian tubercle on under surface; hind femur with small, erect premedian lamella and erect apical spine on under side . . . . . *inusitatum*
— Flagellomere 1 nearly two thirds to three quarters as long as 2; hind tibia merely thickened apically; hind femur thickened and flat on under side, without lamella or spine 4

4. Middle trochanter with long apical spine (largely hidden in long hair); face below antennae pale yellow, legs and metasoma largely yellowish red . . . . . *serratum*
— Middle trochanter without spine; yellow of face limited to lower margin of clypeus; legs brownish black with red areas on front leg; metasoma black with tergal margins reddish. *longitarse*
5. Wings fuliginous; pubescence mostly black . . . . . *aterrimum*
— Wings transparent light brownish or yellowish; pubescence of head and thorax largely pale or fulvous 6
6. T I-V with apical cream colored integumental bands; hind femur and tibia greatly thickened (Fig. 9). . . . . *saussurei*
— Terga without integumental bands; hind femur and tibia not or little thickened 7
7. S V simple; first flagellomere about as long as broad and 1.7 times as long as pedicel . . . . . *bohartorum*
— S V with short, transverse, median basal lamella suggesting a tubercle; first flagellomere much broader than long and about as long as pedicel. 8
8. Hind tibia simple; flagellomeres 2-6 on under side with longitudinal zones of hairs about one sixth as long as flagellar diameter . . *opalinum*
— Distal two fifths of hind tibia parallel-sided, thickened, basal three fifths with broad concavity on lower surface; flagellum without noticeable hairs. . . . . *brooksi*
9. Wings fuliginous; pubescence largely black . . . . . *aterrimum*
— Wings transparent light brownish or yellowish; pubescence of head and thorax largely pale or fulvous . . . 10
10. T I-IV with apical cream-colored integumental bands . . . . . *saussurei*
— Terga without strong pale integumental bands 11
11. Lower half of clypeus sparsely punctate or impunctate with shining ground, in contrast to dull, minutely roughened ground of upper half . . 12
— Lower half of clypeus coarsely punctate throughout with ground between punctures dull, minutely roughened, like that of upper half. 13
12. Malar area about one third as long as flagellar diameter; labrum convex in profile. . . . . *opalinum*
— Malar area nearly as long as flagellar diameter; labrum flat in profile . . . . . *brooksi*
13. First recurrent vein interstitial with first transverse cubital vein; hair of S III-V as long as or longer than exposed parts of sterna, abundant, bright fulvous. . . . . *sinaloa*
— First recurrent vein entering second submarginal cell; hair of S III-V less abundant and best described as apical fringes or much shorter than exposed parts of sterna, fuscous to yellowish white or fulvous 14
14. Midventral hairs of S IV and V much shorter than apical fringes of S II and III; T III and especially T IV with depressed apical zones impunctate basally but with finely and closely punctate apical margins . . . . . *bohartorum*
— Hairs forming long apical fringes on S II-V; T III and IV with apical zones scarcely differentiated, punctation similar to that of discal parts of terga except for finely and closely punctate apical margins 15
15. Apical pale hair bands of T I-IV narrow and of about equal width . . . . . *inusitatum*
— Apical pale hair band of T IV markedly broader than bands of T I-II, T III intermediate. . . . . *serratum*

Mydrosoma opalinum (Smith) new combination

Figs. 5, 6, 71, 76, 77

Apista opalina Smith, 1862:149 (type female, London).

Mydrosoma metallicum Smith, 1879:6 (type female, London).

Egapista opalina: Cockerell, 1904:357.

Apista metallica: Ducke, 1910:362.

Male: 1. Length 13.5 mm; forewing length 10 mm. 2. Inner orbits slightly converging below except upper extremities which converge above. 3. Interantennal distance about equal to

antennocular distance. 4. Interocellar distance equal to nearly 2.5 ocellar diameters, equal to ocellocular distance, greater than ocelloccipital distance which is equal to nearly two ocellar diameters. 5. Distance from median to lateral ocellus less than ocellar diameter. 6. Malar space over half as long as broad, half as long as minimum diameter of basal part of flagellum. 7. Labrum shining, smooth, convex except flattened medially, with two or three small weak ridges across base. 8. Flagellomere 1 much broader than long, less than half as long as 2 which is slightly over 1.5 times as long as broad. 9. Flagellomeres with surfaces convex so that flagellum is weakly crenulate; distal half of flagellum tapering and therefore more slender than basal half in all views; under surfaces of flagellomeres 2-10 with longitudinal zones of short erect hairs, on 3 to 6 over one sixth as long as diameters of segments. 10. Second recurrent vein almost interstitial with or slightly beyond second transverse cubital. 11. Front and middle legs not modified. 12. Hind femur less than three times as long as broad, under surface smooth and slightly concave between pair of weak longitudinal ridges, inner ridge elevated at apex of femur to form weak transverse prominence or lamella. 13. Hind tibia distinctly over three times as long as broad, expanded apically almost to apex, outer surface unmodified, convex, with hairs, inner surface uniformly concave, hairy; transversely striate part of inner surface limited to area close to spurs. 14. Hind basitarsus nearly two thirds as long as tibia, gently arcuate, thickest apically, shorter than remaining tarsal segments together. 15. S V with short, transverse, median elevated lamella in middle of large, smooth, hairless basal area; S VI with small, smooth, rounded, basal convexity in midst of large, smooth, hairless area. 16. Clypeal surface easily visible through vestiture; clypeal punctation coarse, punctures of lower two fifths of clypeus irregular but mostly separated by nearly a puncture width of shining ground, those of rest of clypeus rather dense except for narrow impunctate zone (widest medially) along epistomal suture, interspaces dull, finely roughened; supraclypeal and most of lower paraocular areas dull, with small, dense punctures; frons with larger (but smaller than most of those on clypeus) and well separated punctures on shining but finely roughened ground; upper paraocular area with broad, depressed, impunctate foveal area extending between lateral ocellus and eye where it is scarcely defined. 17. Vertex with scattered very fine punctures, laterally seemingly impunctate, with band of well-separated punctures across posterior margin. 18. Thorax with distinct punctures about as large as those of clypeus, mostly separated by more than a puncture width, denser along lateral margin of scutum, margins of scutellum, and sides of propodeum, and widely separated on disc of scutellum and posterior median part of scutum; surface between punctures shining but not highly polished, in most areas minutely roughened; propodeal triangle shining, minutely roughened, impunctate, with a few fine, weak transverse striae across base. 19. Metasomal terga I-IV more finely punctate than thorax, remaining terga about as coarsely punctate as thorax; interspaces smooth, polished, wider than puncture widths except on T VII; punctures finer and closer toward posterior margins of T I-VI, margins very narrowly impunctate. 20. Sterna with punctures similar to those of terga on similarly shining ground, broad basal impunctate zones on T III-VI, broad apical impunctate margin sharply set off from punctate areas on T II-IV, narrower impunctate margin on T VI. 21. Integument black except as follows: labrum, postmedian band across mandible, and distal tarsal segments red-brown; under side of flagellum brown; legs brownish black; tibial spurs yellowish brown; T I-IV with strong blue to bronze metallic tints, posterior parts slightly brownish; T V-VII brownish black to reddish black; sterna red-brown, S II-IV with translucent apical zones. 22. Wings grayish yellow with apical slightly dusky area beyond marginal cell; veins and stigma light brown except vein R of forewing which is black. 23. Pubescence of head, thorax, legs, T I except posterior margin, extreme sides of T I-VI and metasomal sterna dull yellowish white, more yellowish or weakly fulvous on vertex and thoracic dorsum; many dusky hairs on vertex, posterior lobe of pronotum, anterior lateral area of scutum, outer surfaces of mid and hind tibiae and of hind basitarsus; dusky hairs more sparsely intermixed with pale ones on frons, disc of scutum (forming a weak dark area across scutum but leaving anterior extremity of scutum pale except laterally) and disc of scutellum; labrum, mandible, and under sides of tarsi with yellow hairs; posterior parts of T I, and T II-VII except as indicated above, with hair appressed, brownish dusky, not forming apical hair bands.

Female: 1f. Length 13-14 mm; forewing length 9 mm. 2f. As in male but convergence slight. 3f. Supraclypeal area rather uniformly convex, slightly shorter than distance from its upper end (upper margins of antennal sockets) to anterior margin of median ocellus; interantennal distance less than antennocular distance.

4f. Interocellar distance subequal to ocellocular distance and greater than ocelloccipital distance, the last about 1.5 times ocellar diameter. 5f. Distance from median to lateral ocellus about two thirds of ocellar diameter. 6f. Malar space about one fourth as long as broad, its length about one third of flagellar diameter. 7f. Labrum shining, smooth, distinctly convex. 9f. Middle flagellar segments about as broad as long. 10f. As in male. 14f. Hind basitarsus on outer surface smooth, shining, concave, with hairs sparse and short. 16f. Clypeus with coarse punctures separated by more than a puncture width, lower median area except along margin more sparsely punctate or impunctate, ground of upper half minutely roughened but somewhat shining, especially along slightly elevated midline; rest of face minutely roughened and dull, frons especially so; supraclypeal area with only minute, widely separated punctures; rest of face and genal area with coarser and closer punctures, but finer than those of clypeus; upper paraocular area with broad, depressed, ill-defined, impunctate, shining foveal area extending up between lateral ocellus and eye. 17f, 18f. As in male. 19f. Metasoma with well separated punctures on smooth, shining ground, coarser on posterior terga than elsewhere. 20f. Punctation of sterna finer than that of terga, fine and close on posterior sterna. 21f. Integument of head and thorax black, clypeus (especially lower half to fifth) red brown; tegula red brown; legs and basal three fourths of mandible dark red brown; tibial spurs brown; flagellum light brown beneath except for first segment, otherwise dark brown. Metasomal terga yellowish brown except for dark red brown pygidial plate (in type of *opalinum*) or similar but infuscated so that superficially terga seem blackish (in type of *metallicum*), in either case with strong green, brassy, and in places blue reflections; sterna light yellow brown. 22f. As in male but veins (except R) and stigma red brown. 23f. Hair of lower half of face sparse, grayish, rufescent on lower clypeal margin, labrum and mandible, some yellowish dusky hairs on mandible and lower part of genal area; frons with whitish hair, a few interspersed dusky hairs medially; vertex behind ocelli with hair pale fulvous, some dusky hairs intermixed; dorsum of thorax including lateral pronotal lobe with dense, long, pale fulvous hairs, sparse only in middle of scutum, dusky hairs intermixed abundantly (in type of *opalinum*) or sparsely (in type of *metallicum*) on front half of scutum and disc of scutellum; gena and sides and venter of thorax with dense whitish hair; hair of metasomal terga rather short, mostly dusky laterally and on basal part of T I, scattered dusky hairs intermixed on T V and T VI (type of *opalinum*), or hairs mostly dusky, black laterally and on T I, prepygidial fimbria black except for reddish posterior median area, pygidial fimbria black (type of *metallicum*); posterior margins of T I-IV with narrow apical bands of white plumose hairs arising on extreme margins and extending beyond; metasomal sterna with white hair, II-V with preapical lateral patch of rather short, dusky or black hair and S VI with dusky hair apically (yellowish in type of *opalina*). Hairs of coxae, trochanters, and femora white, blackish on apex of front coxa, undersides of front trochanter and of front femur basally, patches of short dense yellowish hair on under side of mid trochanter and of base of mid femur; scopa of hind femur large, dense, white; apex of hind femur with small area of black hair on upper surface; tibiae and tarsi with hairs dusky to black, darkest on hind legs, yellowish dusky on small segments of tarsi.

The only females seen are the type specimens of *opalinum* and *metallicum* [London]. The color differences between them are noted in the above description. Presumably some or all of these existed when the specimens were fresh. However, the pale wing veins suggest exposure to light, and some of the differences may be due to greater exposure of the type of *opalinum*. The two types are from the same locality and almost certainly conspecific in spite of the color differences.

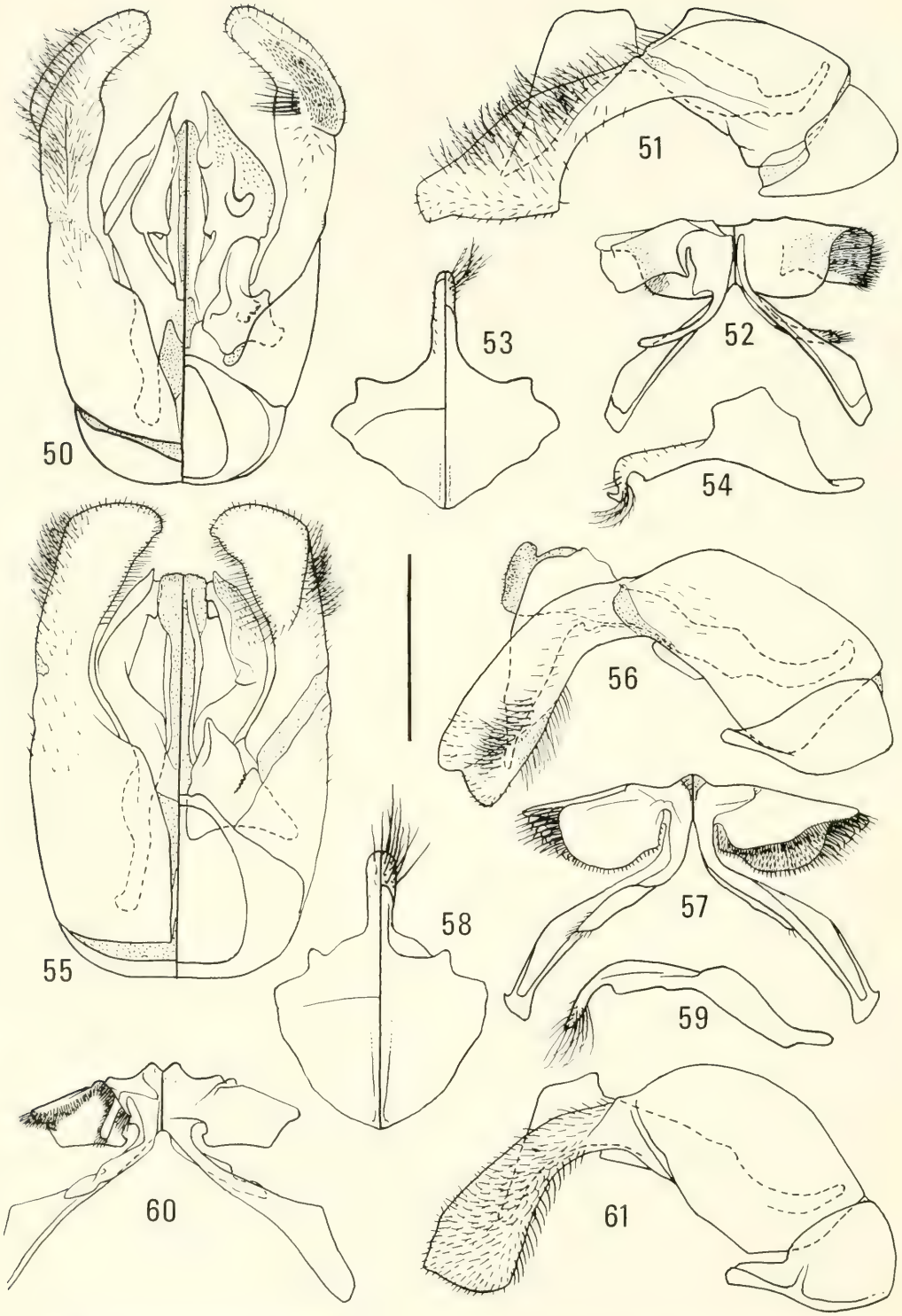
The third known specimen of the species is the male described by Smith (1879), which served as the basis for the above description of that sex. The specimen differs in wing venation from Figure 71 in that the first recurrent vein joins the second submarginal cell about one fourth of the length of the cell from the base. Presumably this difference is neither a specific nor a sexual character.

All three specimens were collected at Ega, which was near Tefé, Amazonas, Brazil [London].

Mydrosoma brooksi new species

Figs. 7, 8, 50-54

Male: Similar to *M. opalinum,* differing from the description of that species as follows: 1. Length 11.5-12 mm; forewing length 9-9.5 mm. 4. Malar space two thirds as long as broad, two thirds as long as diameter of basal part of



Figures 50-59. Explanation as for 17-25. 50-54, *Mydrosoma brooksi;* 55-59, *M. longitarse.*
Figures 60-61. Seventh metasomal sternum and side view of genitalia of male *M. serratum.*

flagellum. 7. Labrum as in *opalinum* but without weak ridges across base. 9. Erect hairs on under sides of flagellar segments so minute as to be unnoticeable, not longer on segments 2-6 than on subsequent segments. 12. Hind femur almost three times as long as broad, under surface smooth and flat, elevated to form small, transverse, preapical lamella basal to which are one or two similar but smaller transverse carinae (holotype has one; one paratype has two on one side, one on the other). 13. Hind tibia with apical third parallel sided, transversely striate and hairless on lower surface; lower inner surface with broad, sharply margined concavity (broken line in Fig. 7) bearing rather short hairs. 14. Hind basitarsus nearly straight, almost parallel-sided. 16. Clypeus with punctation of upper three fifths sparser than that of distal part, punctures separated by two or three puncture widths of finely roughened ground; supraclypeal area with punctures separated by about a puncture width and coarser than those of lower paraocular area. 17. Foveal area even less well defined than in *opalinum*. 19. Distal terga not conspicuously more coarsely punctate than basal ones, interspaces greater than a puncture width even on much of T VII. 20. S V with narrow, apical, impunctate zone. 21. Labrum (in holotype but not all paratypes) infuscated; T I-VI with narrow apical testaceous margins; T I (in holotype but not all paratypes) with brown area. 22. Wings somewhat darker than in *opalinum,* apical dusky area less evident. 23. A few dusky hairs intermixed on scape; pale hair of dorsum of thorax fulvous and of upper pleural areas pale fulvous, dusky hairs as in *opalinum;* outer surfaces of all tibiae with dusky hairs; large brush of long hairs on under side of front femur dusky (faintly so also in *opalinum*); hairs of labrum, mandible, under sides of tarsi and of front tibia orange, somewhat dusky on mandible; sides of T I-VI without pale hairs and pale hairs largely limited to basal half of T I; apical half of T I and all of T II-VII with hairs black except for apical row of yellow hairs across T I-V, forming weak apical bands.

Female: Agrees with description of *M. opalinum* except as follows: 1f. Length 13 mm; forewing length 9 mm. 2f. Inner orbits scarcely converging below, upper extremities converging above. 4f. Interocellar distance less than ocellocular distance. 6f. Malar space over one third as long as broad, its length almost equal to flagellar diameter. 7f. Labrum almost flat in profile. 8f. Flagellomere 1 slightly longer than broad. 10f. Second recurrent vein slightly basal to third transverse cubital (this is probably neither a sexual nor a specific character). 16f. Clypeus with punctures of lower median area not sparser than on upper area, but ground nearly smooth, unlike upper area. 20f. Sterna with apical impunctate margins all narrow. 21f. Clypeus nearly all black; legs black, small segments of tarsi rufescent; distal two thirds of mandible red brown. Metasomal terga black, T I-III with diffuse dark yellow brown preapical bands; metallic reflections blue green, strong on T I-III, weak on T IV, absent on T V; sterna brown. 22f. Dusky hairs pale, inconspicuous, and sparsely intermixed with pale fulvous hair on scutum and scutellum; sides of thorax with hairs ochraceous; tergal hairs mostly black, yellowish at extreme sides and on much of T I; prepygidial and pygidial fimbria and apical bands of T I-IV as in *M. opalinum;* preapical patches of black hair on sterna reduced, indicated only on S II and a few hairs on S V; S VI with hairs black. Hind tibia and basitarsus with hairs of anterior margins yellowish white. (Direct comparison with *M. opalinum* was not possible.)

Type material: Holotype male and three male paratypes, 14 km west of El Llano (Carti road km 9), Panamá Prov., Panamá, April 22, 1981, on *Psychotria luxurians* (R. W. Brooks) [Lawrence]. The locality is about 20 km northeast of Chepo. Allotype female, Cerro Campana, Panamá Prov., July 17, 1977 (R. B. and L. S. Kimsey) [Lawrence]. Two of the paratypes are in the collection of R. W. Brooks.

This species is close to *M. opalinum* but striking differences in hind leg and antennal characters of the male differentiate it. Some of the color differences are probably due to fading of the male specimen of *M. opalinum* which was collected over a century ago.

I am pleased to name this species for Robert W. Brooks, who not only collected the only known male specimens but predicted that they would differ from *M. opalinum* when I suspected that they belonged to that species. The female specimen is also from his collection.

Mydrosoma saussurei (Vachal) new combination

Figs. 9-11, 45-49, 70

Diphaglossa saussurei Vachal, 1909:35 (type male, Paris).

Male: 1. Length 14 mm; forewing length 9 mm. 2. Inner orbits converging below except upper extremities which converge above. 3.

Interantennal distance greater than antennocular distance. 4. Interocellar distance equal to about 2.5 ocellar diameters and greater than ocellocular and ocelloccipital distances; ocellocular distance slightly greater than ocelloccipital distance, the former slightly less than two ocellar diameters. 5. Distance from median to lateral ocellus slightly less than ocellar diameter. 6. Malar space about half as long as broad, length slightly less than flagellar diameter. 7. Labrum shining, smooth, rather flat except for two weak, transverse, basal ridges. 8. Flagellomere 1 as long as broad, about 0.6 times as long as 2 which is slightly over 1.5 times as long as broad. 9. Flagellomeres 4-11 convex on under surfaces so that flagellum is weakly crenulate; distal half of flagellum slightly wider than basal part in upper or lower view but more slender in lateral view. 10. Second recurrent vein interstitial with second transverse cubital or nearly so. 11. Front trochanter with broad, approximately right angular, flat projection on under side near apex; otherwise front and middle legs not modified. 12. Hind femur little over twice as long as broad, under surface with broad concavity delimited by distinct ridge which is carinate or almost so, and in basal inner part is strongly elevated and overhanging margin of cavity, and in distal outer part is produced as thin, acute tooth overhanging cavity. 13. Hind tibia less than twice as long as wide, outer surface with broad, shiny, hairless concavity, inner surface with large shiny hairless area, lower distal part expanded, transversely striate, with deep sinus basal to rounded apical lamella beneath which spurs arise. 14. Hind basitarsus slender, narrowest before middle, as long as tibia, arcuate, especially basally, somewhat shorter than remaining tarsal segments. 15. Exposed sterna without special features. 16. Sculpturing of face largely hidden by long, dense hair; punctation where visible rather dense, coarse on clypeus, much finer elsewhere; upper paraocular area with broad, depressed, impunctate foveal area extending between lateral ocellus and eye where it is not defined. 17. Vertex with scattered fine punctures, coarser in ocellar triangle and band of well-separated punctures across posterior margin. 18. Thorax with distinct punctures, mostly separated by more than a puncture width, denser along lateral margins of scutum, posterior margin of scutellum and sides of propodeum, widely separated on disc of scutellum and posterior median part of scutum; surface between punctures shining (although not smooth) on most of scutum but elsewhere dull and minutely roughened; propodeal triangle minutely roughened, impunctate. 19. Metasomal terga mostly more finely punctate than thorax but posterior terga are coarsely punctate, especially VI and VII, punctures finer and more widely separated toward posterior margins of T I-VI, the margins themselves impunctate, not set off by abrupt change in sculpture from discs of terga. 20. Sterna with punctures similar to those of anterior terga, posterior margins impunctate, not set off by abrupt change in sculpture. 21. Integument black except as follows: labrum testaceous except dark margin; mandible yellowish brown, apical third reddish infuscated; under side of flagellum light brown, upper side dark brown, both sides of last 3-4 segments blackish; tegula orange brown (only slightly darker than labrum); front leg dark brown, small segments of tarsus testaceous; middle leg dark brown, under side of femur orange brown, tarsus progressively paler apically, last two segments orange brown; hind leg including spurs orange brown, coxa, trochanter, and area on upper surface of femur dark brown; T I-V with extremely weak metallic bluish or bronzy tints, with apical, rather narrow, pale yellow, opaque bands occupying more than the impunctate areas along margins; tergum VI and exposed sterna with broad, translucent testaceous apical zones. 22. Wings yellowish, veins testaceous. 23. Pubescence of face long, appressed, golden; of thoracic dorsum yellow, orange on the anterior lateral part of scutum; of genal area and side of thorax including propodeum white, grading to yellowish above; of coxae, trochanters, and femora white, grading to yellow on more distal parts of legs, brush of long hair on under side of middle third of front tibia orange to blackish; of metasomal terga yellow, not forming apical bands or fringes; of sterna yellowish white, longest on posterior part of each, forming apical bands of long hair.

Female: 1f. Length 12-14 mm; forewing

Figures 62-72. Forewings. Scale line = 1 mm. 62, *Cadegualina andina* (Venezuela specimen); 63, Same (type of *Bicornelia sericata* from Ecuador); 64, *Cadeguala occidentalis;* 65, *Diphaglossa gayi;* 66, *Mydrosoma aterrimum* (type); 67, *Cadeguala albopilosa;* 68, *Ptiloglossidia fallax;* 69, *Mydrosomella gaullei;* 70, *Mydrosoma saussurei;* 71, *M. opalinum* (type of *metallicum*); 72, *M. longitarse* (type).

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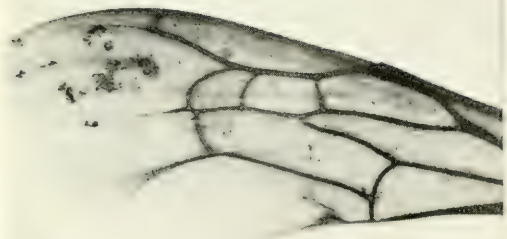

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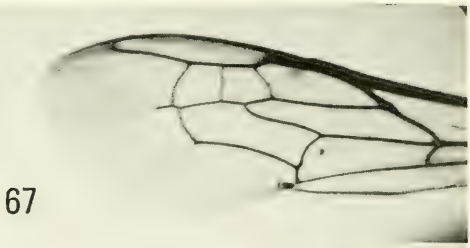

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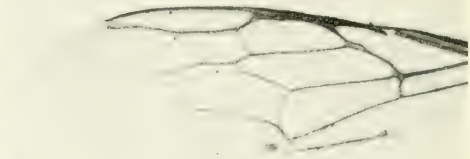

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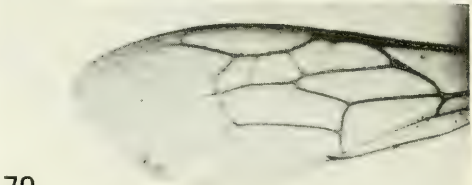

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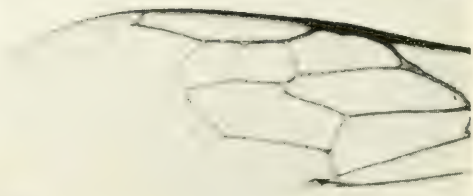

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length 8.5 mm. 2f. As in male but convergence slight. 3f. Supraclypeal area in profile flat below, upper part convex; length of area shorter than distance from its upper end (level of upper margins of antennal sockets) to anterior margin of median ocellus; interantennal distance subequal to antennocular distance. 4f. Interocellar distance more than twice ocellar diameter, subequal to ocellocular distance, much greater than ocelloccipital distance. 5f. As in male. 6f. Malar space about one third as long as broad, length less than flagellar diameter. 7f. As described for male. 9f. Middle flagellomeres slightly longer than broad. 10f. As in male. 14f. Hind basitarsus on outer surface shining, concave, rather sparsely haired medially. 16f. Clypeus coarsely punctured with broad shining interspaces distally, becoming finely and densely punctate basally except for narrow impunctate zone along epistomal suture; rest of face with rather fine punctures, coarser and well separated by minutely roughened ground on supraclypeal area and lower paraocular areas, finer and more densely punctate on frons and upper paraocular areas except scarcely depressed, ill-defined foveal area which is shining with small, scattered punctures; upper part of foveal area, between eye and median ocellus, not recognizable. 17f and 18f. As in male. 19f. Metasomal terga almost as coarsely punctate as scutum; punctures progressively finer and closer toward posterior margins of T I-IV, punctures extending to tergal margins, margins not set off by abrupt change in sculpture from discs of terga. 20f. S I with punctures similar to those of terga; other sterna with somewhat finer punctures, dense toward posterior margins, sparse and on shining ground toward bases. 21f. Integument black; legs, antenna and pygidial plate dark brown, the following orange brown: labrum, mandible (infuscated apically), under side of flagellum, tegula, small segments of tarsi and tibial spurs; T I-IV with stronger metallic blue, green and bronze tints than in male, with apical rather narrow yellow, opaque bands; bases and apices of sterna I-VI orange brown. 22f. As in male. 23f. Pubescence of head and thorax yellowish white, orange with a few intermixed dusky hairs on anterior lateral parts of scutum, yellow on scutellum, golden to orange on clypeal margin, labral margin, mandible, tibiae, and tarsi; metasomal pubescence mostly yellow, not forming apical bands; prepygidial and pygidial fimbriae orange with some dusky orange hairs; T III-V with a few long, apical white hairs on posterior lateral angles; sternal hairs yellow, forming long apical fringes, extreme apices of S I-V with shorter white hairs.

The holotype was from Orizaba, Vera Cruz, México (Biart, 1862). Additional specimens, all from the state of Oaxaca, are one male, 8 km east of Temascal, November 25, 1963 (D. H. Janzen, Berkeley); two females, Temascal, November 5, 1963 (R. F. Smith, Berkeley and Lawrence). So far as known only these four specimens have been collected.

The type agrees well with the male from Oaxaca except that the fringe of long hairs on the under side of the middle third of tibia I is blackish instead of orange.

Mydrosoma aterrimum (Friese) new combination

Figs. 66, 78

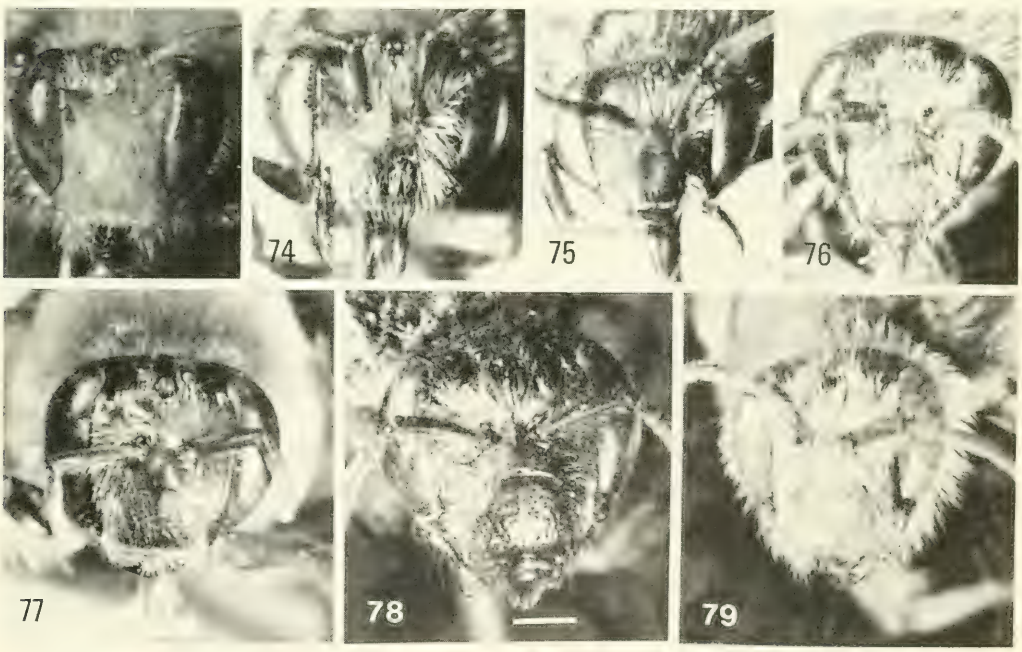
Bicornelia aterrima Friese, 1925:12 (type female, Berlin).

?Dissoglotta stenoceratina Moure, 1945:145 (type male, Curitiba, not seen); Moure, 1953:76.

The following description is based on the female type of *aterrimum*. Moure's description of *stenoceratina*, material of which is not available for study, agrees with *aterrimum* in most features except for smaller size (length 14.5 mm) and somewhat less pale pubescence. Moure's male, however, has some pale hairs suggestive of those of Friese's female. Moreover, Friese's specimen is old and some dark brownish or grayish hairs may have been blacker when fresh, which would have resulted in greater similarity between *aterrimum* and *stenoceratina*. Hesitantly I place the latter name in synonymy.

Female: 1f. Length 17 mm; forewing length 11.5 mm. 2f. Inner orbits parallel except upper parts which converge above. 3f. Supraclypeal area uniformly but gently convex, slightly shorter than distance from its upper end (level of upper margins of antennal sockets) to anterior margin of median ocellus; interantennal distance less than antennocular distance. 4f. Interocellar distance less than ocellocular distance and nearly equal to ocelloccipital distance, the last nearly twice an ocellar diameter. 5f. Distance from median to lateral ocellus less than two thirds of an ocellar diameter. 6f. Malar space nearly one half as long as broad, its length about two thirds of flagellar diameter. 7f. Labrum with medium triangular, elevated, rather smooth area, apical point of this area rounded,

lateral points extended as ridges to sides of labrum. 9f. Middle flagellomeres slightly longer than broad. 10f. Second recurrent vein joining third submarginal cell at apical sixth. 14f. Hind basitarsus on outer surface flat, shining but rather densely haired. 16f. Clypeus with coarse punctures separated by more than a puncture width, coarser in lower half than basally, ground of upper half minutely roughened but somewhat shining, slightly elevated median line of upper half without punctures; rest of face minutely roughened and dull; supraclypeal area with only a few, widely scattered, moderate-sized punctures, rest of face and genal area with well separated, mostly smaller punctures; upper paraocular area with depressed, impunctate foveal area extending up between lateral ocellus and eye. 17f. Vertex largely impunctate but posterior margin and broader area behind ocellar triangle with distinct, well separated punctures. 18f. Thorax with well separated punctures finer than those of clypeus, finer on dorsum than laterally, posterior median part of scutum impunctate, punctures of scutellum and metanotum dense; ground between punctures in most areas shining and rather smooth on dorsum, slightly roughened laterally especially among the more widely separated punctures of side of propodeum; propodeal triangle minutely roughened, impunctate, with only weak traces of minute transverse striae at base laterally. 19f. Metasomal terga I to IV with fine, dense punctures, markedly coarser on T V and VI. 20f. Sterna also rather coarsely punctate, much finer on VI, sterna II-IV and to some degree V with small, shining, largely impunctate area laterally in front of area of especially dense punctures and hair. 21f. Integument black without metallic tints, brownish black on clypeus, reddish black on distal part of mandible and tibial spurs; margins of metasomal terga slightly brownish; basal veins and stigma black. 23f. Hair black, whitish around antennal bases and on small, anterior lateral area on scutum; whitish hairs intermixed on upper lateral part of clypeus; bristles on apex of labrum, some of mandibular hairs, and hairs on under sides of tarsi reddish brown; hairs of under sides of head, thorax, and of mid and hind coxae, trochanters, and femora largely grayish, including under side of the large, dense hind femoral scopa; hair of side of thorax including large, dense propodeal scopa brownish, as is hair of S I and II; terga without apical bands of distinctive hair, but hairs arising to tergal margins, a few white hairs intermixed laterally on T 5; tergal hairs of rather uniform



Figures 73-79. Faces. Scale line = 1 mm. 73, *Ptiloglossidia fallax,* male; 74, 75, *Mydrosomella gaullei,* female and male; 76, 77, *Mydrosoma opalinum,* male and female (type of *M. metallicum*); 78, *M. aterrimum* (type); 79, *M. longitarse* (type).

length, moderately short, decumbant, except for the much longer hairs of the prepygidial and pygidial fimbriae.

The species is known from only two localities. The type of *aterrimum* is from Tarata, Cochabomba, Bolivia (1900), while the two known specimens of *stenoceratina* are from Itatiaia, Rio de Janeiro, Brazil, the male type from an altitude of 700 m. The female, described by Moure in 1953, was evidently labelled as an allotype but was not a paratype, hence is not a genuine allotype.

Mydrosoma longitarse (Friese) new combination

Figs. 12, 13, 55-59, 72, 79

Bicornelia longitarsis Friese, 1925:11 (type male, Berlin).

Male: 1. Length 17 mm; forewing length 11 mm. 2. Inner orbits subparallel except upper extremities which converge above. 3. Interantennal distance subequal to antennocular distance. 4. Interocellar, ocellocular and ocelloccipital distances about equal, each about two ocellar diameters. 5. Distance from median to lateral ocellus nearly two thirds of an ocellar diameter. 6. Malar space nearly as long as broad, length slightly greater than flagellar diameter. 7. Labrum shining, smooth, uniformly convex except for weak transverse basal ridge. 8. *Flagellomere 1 more than twice as long as pedicel and nearly as long as 2* which is twice as long as broad; middle flagellomeres twice as long as broad; 9. *Flagellum crenulate beyond fourth segment,* or serrate with projection on each segment low and rounded, markedly lower than in *M. serrata* and *inusitata;* distal segments more slender than basal ones. 10. Second recurrent vein slightly basal to third transverse cubital. 11. Front and middle legs not modified. 12. Hind femur about 2.5 times as long as broad, under surface flat except for low protuberance on inner margin at apical third. 13. Hind tibia about 2.7 times as long as broad, swollen and transversely striate on under surface distally and produced to a rounded lamella just before bases of spurs. 14. Hind basitarsus cylindrical, over three fourths as long as tibia, slightly shorter than remaining tarsal segments. 15. Exposed sterna without special features except low, median impunctate biconvex elevation on S VI. 16. Sculpturing of face largely hidden by long, dense hair; punctation where visible dense; upper paraocular area with broad, depressed, impunctate foveal area extending up between lateral ocellus and eye. 17. Vertex impunctate except for zone of distinct punctures along posterior margin. 18. Thorax with strong punctures mostly separated by less than a puncture width, fine and close around margins of scutellum and posterior margin of scutum, sparser in posterior middle part of scutum, impunctate discal area on scutellum; surface between punctures shining but on sides of thorax minutely roughened; propodeal triangle minutely roughened, impunctate. 19. Metasomal terga more finely punctate than thorax, punctures finer and closer toward posterior margins of T I-VI but margins proper rather narrowly translucent and impunctate. 20. Sterna I-VI more coarsely punctate but with similar impunctate apical margins. 21. Integument black except as follows: lower margin of clypeus, labrum, mandible except dark red apex, tegula, areas on under sides of fore and mid femora, front tibia (darkened along posterior margin), tibial spurs, and posterior translucent margins of metasomal terga and sterna testaceous; antenna dark brown, under side of flagellum light brown; legs except as indicated above brownish black, lighter toward apices of tarsi; apices of metasomal terga I-VI, basal to translucent margins, broadly red brown. 21. Wings slightly yellowish brown, veins and stigma testaceous except vein R which is blackish. 22. Pubescence of face long, dense, yellowish white; of ventral surface of head white; of thorax long, dense, light fulvous above grading to white on venter, coxae, trochanters, and under sides of fore femur and tibia; of rest of legs yellowish, yellow on under sides of tarsi; of metasomal terga fulvous, rather dense on apical halves of I-VI, sparser and more erect on basal halves; reddish black hairs intermixed on T V-VII; posterior margins of T I-V with rather narrow apical fringes of plumose yellow hairs; sterna II-V with apical bands of long yellowish hair.

This species is known from a single male specimen from Blumenau, Santa Catarina, Brazil (1900).

Mydrosoma inusitatum (Snelling) new combination

Figs. 14, 15

Bicornelia inusitata Snelling, 1980:3 (holotype male, Lawrence).

This panamanian species was described and illustrated by Snelling. The following characters are added to his description.

Male: Malar space about one fourth as long as wide, length less than half diameter of flagellomere 1. Second recurrent vein slightly basal to third transverse cubital. Hind tibia on lower side preapically with weakly indicated striae, equivalent to those of *M. longitarse* but much weaker. Tegula reddish.

Female: Malar space virtually absent. Tegula dark brown. Head and thorax black, legs dark brown, tibial spurs light brown; metasomal terga brownish black with broad, undefined brown posterior zones, grading into translucent yellowish apical margins; extremely faint bluish or greenish reflections medially on T II and III; fuscous hairs of scutum and scutellum intermixed with ocherous hairs; hairs of apex of hind femur and outer surface of hind tibia black, those of tarsi and tibiae otherwise fuscous except for white on lower margin of hind tibia and on base of that margin of basitarsus; prepygidial fimbria black basally, posterior part consisting of fringe of yellowish red hairs.

The type locality is Madden Forest Preserve (formerly in the Canal Zone), Panamá Prov., Panamá. Additional females were taken from Panamá Province: 23 km northeast of Chepo at km 8 on El Llano-Carti road, on flowers of *Psychotria luxurians,* June 5 and 10, and July, 1982 (D. W. Roubik) [Balboa and Los Angeles].

As noted earlier, males of this species and the next exhibit a considerable series of distinctive synapomorphies. The following is a partial list: Face largely yellow; flagellum strongly serrate (see Figs. 2 and 4 of Snelling, 1980); middle trochanter with thin, transparent apical spine (Fig. 6, Snelling 1980); S VII with basal lateral lobes straplike, modified and perhaps twisted apically, hairless; dorsal distal lobe of S VII reduced to slender projection (Fig.11, Snelling, 1980); S VIII with small but strongly projecting lateroapical lobes (Figs. 8, 10, Snelling, 1980); gonocoxite with inner apical lobe on dorsal surface (Figs. 12, 13, Snelling, 1980). On the basis of these characters one could apply the name *Bicornelia* to these two species, but the remaining *Mydrosoma* would then constitute a paraphyletic taxon or would have to be divided into about four genera. As noted above, the similarity of females of *M. bohartorum* to those of *M. serratum* and *inusitatum* further discourages any suggestion of generic or subgeneric status for *Bicornelia.*

Figures 60 and 61 are provided to supplement Snelling's illustrations of *M. serratum* and *inusitatum.* Note that the gonostylar hairs of both species are longer than shown by him and that the gonobase is well developed, as in other *Mydrosoma.* In lateral view the genitalia are similar in the two species. The structure of S VII is also similar in the two species; Snelling shows the specific differences.

Mydrosoma serratum (Friese) new combination

Figs. 16, 60, 61

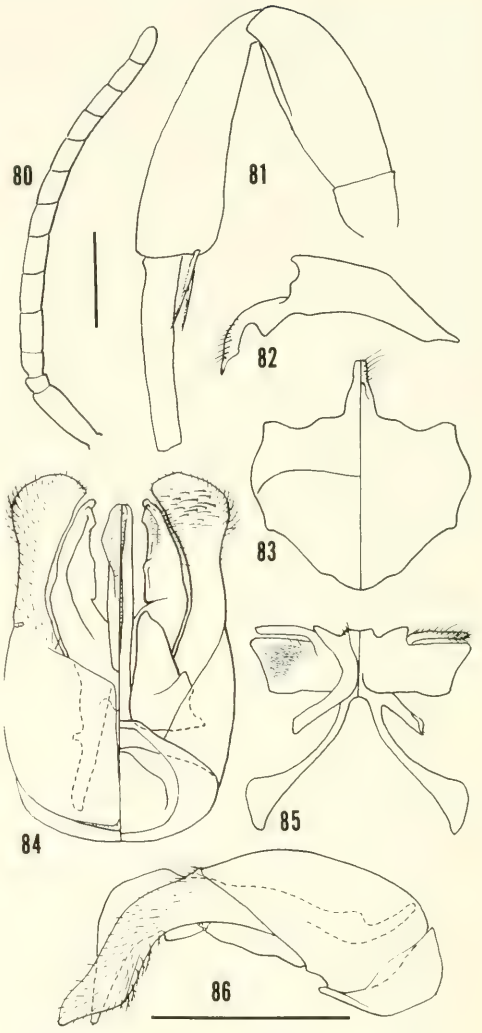
Bicornelia serrata Friese, 1899:240; Snelling, 1980:3 (holotype male, should be in Berlin, but according to Dr. Frank Koch, cannot be found).

This Mexican species was redescribed and illustrated by Snelling. The supplementary characters indicated above for *M. inusitatum* apply also to *M. serratum.* In spite of the reddish yellow background color of the metasoma, one can see weak bluish or greenish reflections on T I-IV.

The female has not been described. It agrees with Snelling's (1980) description of the female of *M. inusitatum* as elaborated and modified above except as follows: size larger (length 14 mm, forewing 9.5 mm); distal two thirds of front femur and most of front tibia red; distal quarter of mid femur and mid tibia except most of outer surface red; base of outer surface of hind tibia red brown; T I-IV with distinct blue or green reflections; sterna nearly as dark as terga; hairs of tibiae and tarsi more brown than fuscous, only middle third of hind tibia with black hairs on outer surface; hind basitarsus without white hairs; apical whitish fringe of T IV markedly longer than fringes of T I and II, T III intermediate.

According to Friese, the type, from México, was labelled "Tuzantlu Laurel"; the locality, as Snelling suggests, may have been Tuzantla in the state of Michoacan. Other specimens were recorded by Snelling from 7 km NW of Tequila, Jalisco, México. The species has also been taken at

the Estacion de Biologia near Chamela, Jalisco, Oct.10, 1982 (a male) and Oct. 22 and 23, 1982, Oct. 26 and Nov. 11, 1983 (females) (S. H. Bullock, collector). In 1985 specimens of both sexes were taken at the same place (along dry water courses in xeric forest) on October 5, 6, and 24 by S. H. Bullock, R. Ayala, J. G. Rozen, Jr., T. Griswold and F. W. Parker. At least at Chamela the species appears to be restricted to flowers of *Triumfetta acracantha* (Tiliaceae) which are open only in late afternoon. Except as noted below, all captures were on this plant from 1730-1800 hrs. Bullock (in litt.) reports that the pollen on specimens available to him is of one type and looks like that of *Triumfetta.* Rozen (in litt.) notes that on October 5 and 6 some females "carried conspicuous amounts of yellow pollen. Both males and females flew swiftly, with little or no hovering, but the females . . . lingered more at the flowers." Males "flew from one clump of the pollen plant to the next, spent little time at any one clump." The *Triumfetta* shrubs were not common, but were widely dispersed along an arroyo on the Chamela reservation. In addition to captures on that plant, two females were taken at dawn sucking nectar from *Cucurbita,* but intensive examination of *Cucurbita* flowers at dawn and later by bee specialists near Chamela in 1985 revealed no *Mydrosoma.* One specimen was taken by Griswold and Parker in a Malaise trap.

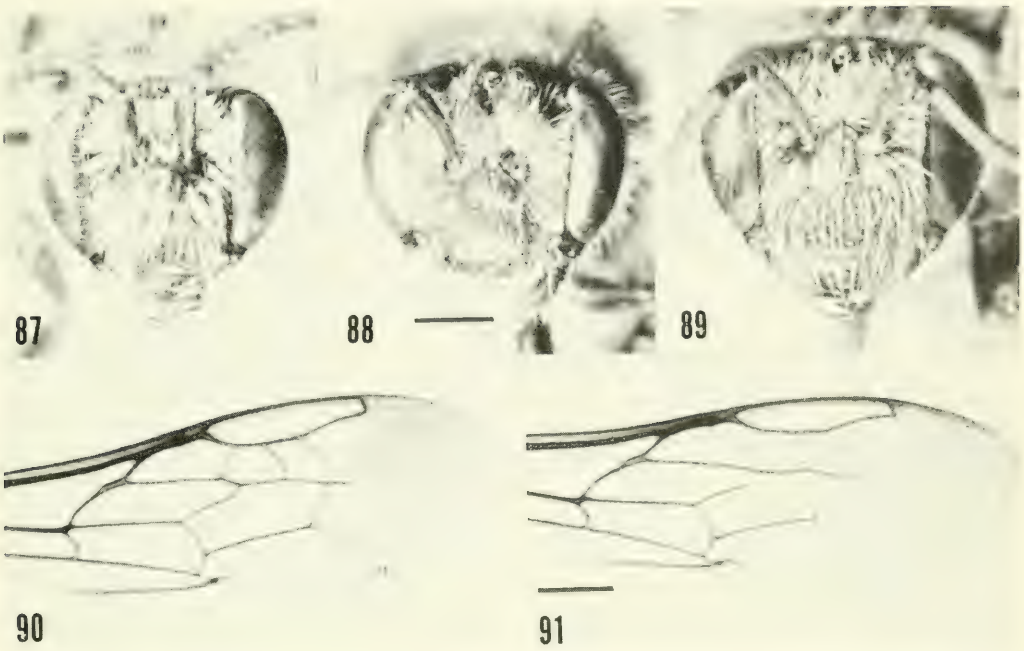


Figures 80-86. *Mydrosoma bohartorum,* male. Scale lines (for leg and antenna, and for terminalia) = 1 mm. 80, Antenna; 81, outer view of hind leg; 82, 83, lateral, dorsal, and ventral views of eighth sternum; 84, dorsal and ventral views of seventh sternum; 85, 86, dorsal, ventral and lateral views of genitalia.

Mydrosoma bohartorum new species

Figs. 80-88, 90

Male: 1. Length 10-11 mm; forewing length 9 mm. 2. Inner orbits more strongly converging below than in *opalinum,* upper extremities converging above. 3. Interantennal distance about equal to antennocular distance. 4. Interocellar distance equal to 2.5 ocellar diameters, slightly less than ocellocular distance, slightly greater than ocelloccipital distance which is equal to about two ocellar diameters. 5. Distance from median to lateral ocellus slightly less than ocellar diameter. 6. Malar space less than one fourth as long as broad, about one third as long as diameter of second segment of flagellum. 7. Labrum shining, smooth, convex except flattened medially, with two small ridges across base. 8. *Flagellomere 1 about as broad as long,* over half as long as 2 which is nearly 1.5 times as long as broad. 9. Flagellum not crenulate, distal half tapering, no hairy zones as in *M. opalinum.* 10. Second recurrent vein joining second submarginal cell near end of its first third (or quarter). 11. *Legs unmodified.* 12. Hind femur less than three times as long as broad, under



Figures 87-89. Faces. Scale line = 1 mm. 87, *Mydrosoma bohartorum,* male paratype; 88, same, female allotype; 89, *M. sinaloa,* female holotype.

Figures 90-91. Forewings. Scale line = 1 mm. 90, *Mydrosoma bohartorum* (paratype); 91, *M. sinaloa* (holotype).

surface smooth, distal half slightly concave. 13. Hind tibia well over three times as long as broad, expanded gradually toward apical third, outer surface convex and hairy, inner surface slightly concave and bare near and basal to middle; *transverse striae lacking.* 14. Hind basitarsus nearly two thirds as long as tibia, nearly straight, thickest near base but tapering only slightly, about as long as remaining tarsal segments taken together. 15. *S V simple,* hairy except for impunctate apical zone which is widest medially; *S VI simple,* hairy except for bare apical margin. 16. Clypeal surface easily visible through sparse vestiture, punctures coarse and very shallow so that surface is coarsely reticulate, more strongly so apically and weakly so basally; ground in and between punctures minutely roughened and dull; supraclypeal area and adjacent part of paraocular area with small dense punctures on dull ground; rests of paraocular area and frons with punctures minute, widely scattered on dull ground, but upper paraocular area and vertex between ocelli and eye broadly depressed, smooth, shining, and hairless. 17. Vertex largely impunctate except band of small but strong punctures across posterior margin. 18. Thorax with large punctures, those of scutum about as large as on lower clypeus; posterior disc of scutum and center of scutellum with punctures separated by a puncture width or more, and hypoepimeral area with lower and anterior margins impunctate, elsewhere punctures closer; surface between punctures minutely roughened but more shining than face; propodeal triangle minutely roughened but rather shiny. 19. Metasomal terga with punctures about as coarse as on thorax, coarser on T VI; ground between punctures shining and rather smooth, a little roughened on T VI and distinctly so on T VII; T I-VI with broad apical zones of slightly finer and more widely spaced punctures, this zone scarcely recognizable on T I but *broadly impunctate basally on T III-V;* some fine punctures near the margins of T III-V. 20. Sterna and lateral parts of terga with punctures closer and coarser than on tergal dorsa, S I-VI with well defined, impunctate, bare, apical marginal bands. 21. Integument black except as follows: mandible with apical half dark red; flagellum with under side dark brown; tegula, tarsi (except largely black claws), apices of fore and mid tibiae, and anterior side of fore tibia yellow-brown (ill-defined premarginal bands on T II and III of

paratype dark brown); TI to V with faint bluish and greenish reflections; apical margins of terga and of sterna I-V translucent brownish. 22. Wings, especially apical third, brown, veins and stigma brown except vein R of forewing which is blackish. 23. Pubescence yellowish white, white on thoracic venter and metasoma, yellow on tarsi and fore tibia, dusky hairs on discs of T III-V; all hairs of T VI and VII dusky; T II (laterally) and III-V with sparse apical bands of whitish hair.

Female: 1f. Length 11.5 mm; forewing length 9 mm. 2f. As in male but orbits only slightly converging. 3f. Supraclypeal area rather uniformly convex except for protuberant frontal tubercle, markedly shorter than distance from its upper end (upper margins of antennal sockets) to anterior margin of median ocellus; interantennal distance equal to antennocular distance. 4f. Interocellar distance shorter than ocellocular distance and greater than ocelloccipital distance, the last about 1.3 times ocellar diameter. 5f. Distance from median to lateral ocellus about three fifths of ocellar diameter. 6f. As in male but malar space less than one fifth as long as broad. 7f. Labrum shining, nearly smooth with a complete ridge and several incomplete small ridges across base. 9f. Middle flagellar segments as broad as long. 10f. As in male. 14f. Hind basitarsus as in *M. opalinum* but scarcely concave. 16f. Clypeal surface gently convex with coarse punctures, mostly separated by less than a puncture width below, becoming finer and denser above; ground in and between punctures minutely roughened and dull; disc of supraclypeal area impunctate but dull, lateral margin of that area, paraocular area, and frons with small punctures, surface dull, except for ill-defined fovea on upper paraocular area and extending between ocelli and eye which is impunctate, shining, but minutely roughened. 17f. As in male. 18f. As in male but punctures finer than largest ones of clypeus. 19f. Metasomal terga with punctures dorsally finer and sparser than on thorax except for T V, ground and apical zones as in male but impunctate bases of these zones on T IV and V only and ill-defined, broken medially on T IV by scattered punctures; small dense punctures on apical margins of T I to IV. 20f. Sterna with punctures dense, finer than on corresponding terga. 21f. Integument black, legs dark brown especially toward apices; mandible with apical half dark red; under side of flagellum, tegula and tibial spurs light brown; anterior side of fore tibia and small segments of tarsi red-brown; T I-IV with faint bluish and greenish reflections; S I-V with posterior margins and bases (not always exposed) red-brown. 22f. As in male. 23f. Hair largely yellowish white but light fulvous with a few fuscous hairs intermixed on vertex, dorsum of thorax, and pronotal lobe; yellow on clypeal margin, mandible, labrum, front coxa, front and mid tibia, and upper sides of all tarsi; orange on under sides of tarsi. Outer side of hind tibia with black hairs on basitibial area, grading through brown to yellowish beyond middle of tibia; apex of hind femur with brown hairs. Short hairs on discs of T III and IV fuscous; T V with hairs blackish except white at extreme sides and coppery in middle of apical margin. S I and II with hairs yellowish white, forming long, preapical fringes; *on other sterna hairs shorter, widespread over surface,* fringes less conspicuous, especially on S V; S III with hairs yellow; S IV to VI with hairs orange to fulvous. Posterior margins of T I-IV with narrow bands of white plumose hairs arising from tergal margins and extending beyond them; band of T IV not appreciably wider than others.

Type material: Holotype male, allotype female, and one male and three female paratypes, 15 mi (24 km) northeast of Guadalajara, Jalisco, Mexico, September 17, 1970 (G. E. and R. M. Bohart). [Holotype and allotype, Mexico; one female paratype, Lawrence; other paratypes, Logan.]

The species is named for the brothers George E. and Richard M. Bohart who collected the specimens and have contributed so much to the knowledge of Hymenoptera.

Mydrosoma sinaloa new species
Figs. 89, 91

Female: 1f. Length 11.5 mm; forewing length 9.5 mm. 2f. Inner orbits scarcely converging below; upper parts strongly converging above. 3f. *Supraclypeal area only slightly convex below frontal tubercle; clypeus in profile flat in upper four fifths, then abruptly declivous to shining marginal zone;* supraclypeal area about as long as distance from its upper end (upper margins of antennal sockets) to anterior margin of median ocellus; interantennal distance about equal to antennocular distance. 4f. Interocellar distance equal to ocellocular distance and greater than ocelloccipital distance which is about 1.5 times ocellar diameter. 5f. Distance from median to lateral ocellus about two thirds of ocellar diameter. 6f. Malar space less than one fifth as long as broad, its length about one third of flagellar diameter. 7f. Labrum shining, smooth, convex, with ridge

across base. 9f. Middle flagellar segments slightly longer than broad. 10f. *Second recurrent vein interstitial with first transverse cubital.* 14f. Hind basitarsus on outer surface smooth, shining, scarcely concave, with hairs rather short and sparse. 16f. Clypeus with punctures fine and close near upper and lateral margins, progressively coarser toward lower margin of flat part of clypeus; except near that margin punctures so close that surface is coarsely reticulate, a narrow, irregular longitudinal median ridge slightly more elevated than other ridges between punctures; below lower edge of flat part of clypeus is declivous finely and closely punctate band leading to smooth impunctate margin which is broader than in similar species, about as wide as base of first flagellar segment; surface both within and between punctures minutely roughened but shining; rest of face minutely roughened and dull, frons especially dull; supraclypeal area with punctures on margins but disc without punctures; rest of face and genal area with punctures similar to or finer than finest punctures of clypeus, on frons especially scattered and small; upper paraocular area with broad, depressed, ill-defined, impunctate, shining foveal area extending up between ocelli and eye. 17f. Vertex largely impunctate and shining except for band of small punctures across posterior margin. 18f. Thorax strongly punctate, punctures much smaller than largest ones on clypeus; discs of scutum and scutellum without areas of especially widely separated punctures but anterior and lower margins of hypoepimeral area impunctate; surface between punctures minutely roughened but more shiny than most of face; propodeal triangle minutely roughened but rather shiny. 19f. Metasoma with punctures finer than those of thorax except for T V, ground shining, only feebly minutely roughened; terga with broad, apical zones poorly differentiated but with punctures slightly sparser than on rest of terga, especially on T III and IV; small dense punctures on apical margins of T I to IV. 20f. Sterna with punctures dense, similar to those of sides of corresponding terga. 21f. Integument black; lower three fourths of clypeus, under side of scape, and legs dark reddish brown; lower margin of clypeus, basal two thirds of mandible, under side of flagellum, tegula, tibial spurs, anterior side of front tibia, and small segments of tarsi yellow-brown; posterior margins of T I to IV narrowly pallid; T I-IV with faint bluish and greenish reflections; posterior margins of S I to V bright fulvous. 22f. Wings light brown, veins and stigma brown except vein R of forewing which is black. 23f. Hair largely yellowish white but light fulvous *without dark hairs intermixed* on vertex, dorsum of thorax and pronotal lobe; yellow on clypeal margin, mandible, and labrum; yellowish orange on tibiae and tarsi, verging toward dusky on outer sides of front and mid tibiae and dusky, blackish toward base, on outer side of hind tibia. Short hairs on discs of T II to IV fuscous; T V with black hairs, ochraceous at extreme sides and coppery in middle of apical part. *Hairs about equally long on S II to V,* yellowish white on S II, *bright fulvous on S III to V.* Posterior margins of T I-IV with narrow bands of white plumose hairs arising from extreme tergal margins and extending beyond them; band of T IV not wider than others.

Type material: Holotype female, 50 miles (80.5 km) northeast of Mazatlan, Sinaloa, Mexico, September 9, 1970 (W. J. Hansen, T. L. Whitworth) [Mexico].

This is the northernmost known *Mydrosoma.* The specific name is a noun in apposition—the state in which the specimen was collected. The most distinctive features are italicized in the above description.

Species Incorrectly Included in Diphaglossine Genera

The species listed below were described as members of diphaglossine genera but are now known to belong elsewhere:

Species	Current Position
Apista gaullei Vachal, 1909	*Eulonchopria* (Michener, 1985)
Apista limbella Vachal, 1909	*Eulonchopria* (Michener, 1985)
Diphaglossa spinolae Crawford & Titus 1904	*Mourecotelles* (Toro & Cabezas, 1977)
Diphaglossa ecuadoria Friese, 1925	Undescribed paracolletine genus

Acknowledgements

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well as the opportunity for field work relating to it. Dr. J. G. Rozen, Jr. of the American Museum of Natural History, also supplied an account of his experience with the same species at the same place. Joetta Weaver did the necessary typing and editing.

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A Revision of the Crane Fly Genus *Dicranoptycha* in North America

By
Chen Wen Young

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THE UNIVERSITY OF KANSAS
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REVISION OF THE CRANE FLY GENUS DICRANOPTYCHA IN NORTH AMERICA[1]

CHEN WEN YOUNG[2]

ABSTRACT

Twenty-three nearctic species are recognized. *D. microphallus* is a synonym of *septemtrionis* and *D. rogersi* a synonym of *sobrina*. *D. byersi* (Appalachian North Carolina and Tennessee) and *D. spinifera* (Appalachian Mountains from Pennsylvania to northern Georgia) are described as new. External morphology of adults, larvae and pupae, ecological occurrence, life cycle and behavior are discussed. All species are described uniformly, illustrated, and identified by a key. Geographic and seasonal distributions of each are summarized. Phylogenetic relationships of *Dicranoptycha* to other Limoniinae are considered, and geographic distribution of nearctic species groups is interpreted in comparison to worldwide distribution of the genus.

INTRODUCTION

Although the subfamily Limoniinae includes many genera with large numbers of nearctic species, only one comprehensive generic revision, on *Chionea* (Byers, 1983), has been undertaken for the entire region. For the family Tipulidae as a whole, the only other monographic revision of a major genus so far published in North America is that on *Dolichopeza* (Byers, 1961).

One limoniine genus in which the taxonomy has been complicated due to a lack of a sound morphological basis is *Dicranoptycha* Osten Sacken, which at present includes 23 nearctic species (Alexander, 1965:52). A revision of the five European species of this genus was published by Starý (1972). Alexander (1942, 1967) dealt with ten eastern and six western Nearctic species.

Difficulties were encountered with the existing keys in identifying some *Dicranoptycha* species from eastern Kansas. These keys rely heavily on color characters and do not include females. Original descriptions were often inadequate due to a lack of specific characters, lack of figures of distinctive structures, incorrect illustrations, and inconsistent usage of anatomical terms which were not in agreement with the current understanding of morphology of Tipulidae. After examining the type specimens, it became obvious that many specimens in collections were misidentified.

The primary object of this revision is to present a taxonomic treatment of *Dicranoptycha* of North America. Attempts have been made to define species using morphological characters, especially of male and female genitalia, and less emphasis has

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been placed on color. Illustrations and keys based on morphological characters of both male and female are provided to assist in the identification of species. A second object is to examine series of specimens from various localities and study the variation to determine what constitutes a species within this genus. Since so little biology of crane flies has been studied and since many regional faunas are still incompletely known, the zoogeography and phylogeny of *Dicranoptycha* as presented here are tentative.

ACKNOWLEDGEMENTS

I thank Dr. George W. Byers, who introduced me to the study of crane flies, for his advice on many occasions, for his willingness to help at any time, for his patience in improving the manuscript, and above all for his concern during my stay in the United States. This study was supported by the National Science Foundation under Grant DEB-77-15868, George W. Byers principal investigator.

A most pleasant and profitable visit was to Amherst, Massachusetts, as the guest of the late Dr. Charles P. Alexander, who took time to show me his personal collection of Tipulidae in "Crane Fly Haven" and allowed me to examine the types and other specimens of *Dicranoptycha*. I also thank the faculty and students of the Department of Entomology, University of Kansas, for their support and helpful discussions, particularly Dr. Charles D. Michener and Dr. Peter D. Ashlock, who read and criticized this paper.

Thanks are due the following persons who have generously assisted by providing specimens from collections in their charge: P. H. Arnaud, S. I. Frommer, C. L. Hogue, W. N. Mathis, F. W. Mead, J. Miller, L. L. Pechuman, J. A. Powell, R. O. Schuster, H. J. Teskey, M. K. Thayer, W. J. Turner, and P. Wygodzinsky.

My special thanks go to Adam Bossert for his valued friendship and assistance. Finally, I would like to thank my parents for teaching me the value of education, for helping provide the opportunity for study in the United States, and for their encouragement.

MATERIALS AND METHODS

Nearly 3500 specimens have been examined for this study. Most were collected from their natural habitats, and are preserved in the Snow Entomological Museum, University of Kansas (SEM), but many were borrowed from other entomological collections. Besides intensive field collecting carried on in the principal study area, the oak-hickory forest of eastern Kansas, field collections were made in other regions of the United States, including the Appalachian Mountains, the Sierra Nevada, and other parts of California.

Institutions loaning material used in this study (and abbreviations used below) are the following: American Museum of Natural History (AMNH), California Academy of Sciences (CAS), Canadian National Collection (Department of Agriculture) (CNC), Cornell University (CU), Florida State Collection of Arthropods (FSCA), Harvard University (MCZ), Los Angeles County Museum of Natural History (LACM), National Museum of Natural History (NMNH), University of California (Berkeley, Davis, and Riverside) (CIS, UCD, UCR), University of Michigan Museum of Zoology (UMMZ), and Washington State University (WSU).

Type specimens of most of the North American and several exotic species of *Dicranoptycha* have been examined in the collection of Charles P. Alexander at Amherst, Massachusetts, which is now housed in the NMNH.

Net sweeping was the basic method of collecting. Inspections were made at potential habitats, places where the forest has poorly developed understory trees, and where the forest floor is generally open and dominated by short undergrowth (45 - 60 cm), partially shaded, with humidity low enough that grass is usually absent. In such habitats, flies were taken either at their resting sites, or in the air as they took flight. Specimens were either mounted or preserved in 70% alcohol. Most mating pairs were preserved in alcohol. The methods used for preparation of field collected material are those of Byers (1961: 677).

External structural characteristics of adults were examined on pinned specimens and on specimens preserved in alcohol when possible. Male and female genitalia for dissection were prepared by removing the posterior abdominal segments and gently boiling them in a solution of 10% KOH for about three minutes to soften the structures enough to be easily dissected. They were rinsed with acetic acid and water after removal from KOH before being placed in glycerine for examination. Dissected parts were preserved in glycerine in a microvial attached to the appropriate specimen pin. Line drawings of internal reproductive structures were made from these KOH-treated specimens. Only two measurements of adult *Dicranoptycha* were made, body length and wing length. The former is the straight-line distance from the anterior end of the head to the tip of the abdomen; the latter is

the straight-line distance between the attachment of the wing and its tip. All measurements were made with the aid of an ocular grid.

Larvae were collected at the University of Kansas Natural History Reservation, about 5 miles northeast of Lawrence, Kansas. Field collected larvae provided with organic debris from the natural habitat grew in the laboratory and transformed into pupae and adults normally. Attempts to rear larvae from eggs were unsuccessful. Adult females usually are unwilling to oviposit in the laboratory; however, if the mature adult female is pinched at the neck region with a pair of fine forceps, she will start ovipositing and usually finish laying all the eggs in a short period. Methods for preserving larvae and pupae are those of Byers (1961: 679).

Field observations of *Dicranoptycha* species in their natural habitats were made at numerous places in addition to the principal study area. These included data about their natural history, behavior, and ecology.

The Genus *Dicranoptycha* Osten Sacken

The genus *Dicranoptycha* was first proposed in 1859 by Osten Sacken. His four included species were *Dicranoptycha germana, nigripes, sobrina,* and *sororcula.* In 1869, Osten Sacken redescribed the genus and recognized *D. sororcula* as a synonym of *sobrina.* Since Osten Sacken did not mention a type species, *D. germana* was subsequently so designated by Coquillett (1910). About 80 species have been recognized from most of the major land masses. There is one fossil record from the Baltic Amber. Until recently, the genus has not been divided into subgenera. In 1970 Savchenko placed a single species, *D. mirabilis,* from Soviet Central Asia (Tajikistan, Turkmenistan), in a separate subgenus *Ulugbekia,* on the basis of its hypopygial structures.

Twenty-three North American species are recorded by Alexander (1965). Of these, I regard 21 as valid. *D. microphallus* and *rogersi* are treated in this study as synonyms of *septemtrionis* and *sobrina,* respectively. Two new species, *D. byersi* and *spinifera,* are described below.

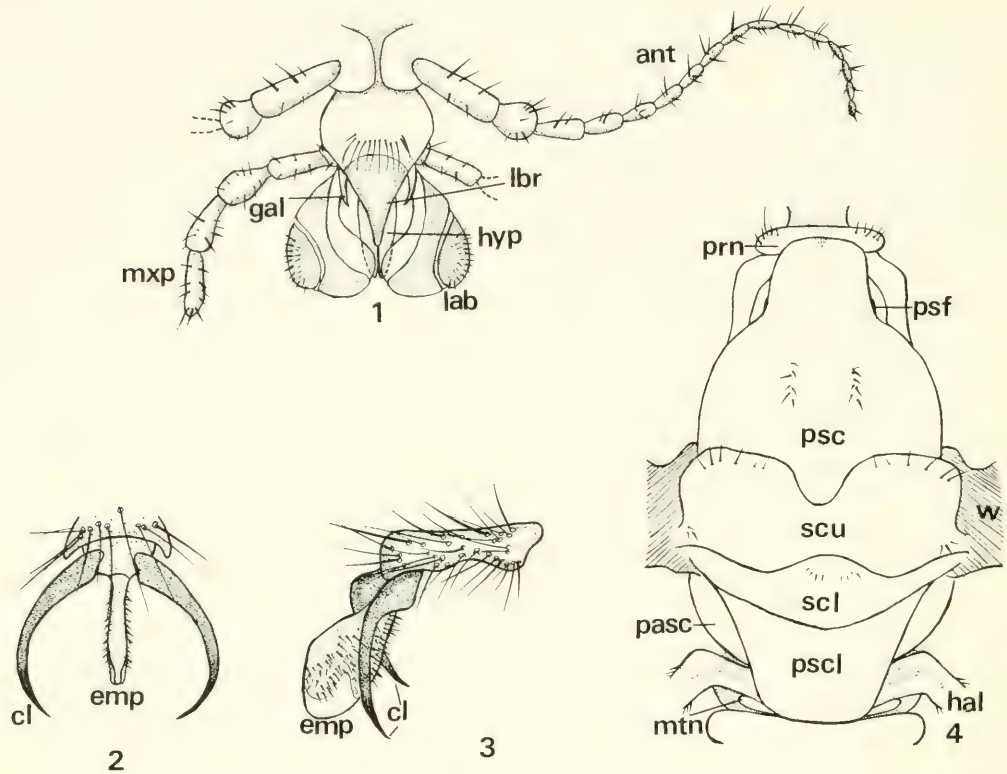
External Morphology of Adults

This section is presented to clarify terminology used as a basis for the following taxonomic descriptions. It should also serve as a basis for comparison of *Dicranoptycha* with other genera. Although McAlpine's terminology is probably desirable to facilitate phylogenetic comparisons of the Tipulidae with other families, the terminology used here is that of Byers (1961) because of its past use in tipulid taxonomy. The morphology of *Dicranoptycha megaphallus* is used here as representative of the genus and is similar to that of other North American species of *Dicranoptycha* unless otherwise stated.

Dicranoptycha is a genus of medium-sized crane flies within the tribe Limoniini. Characteristics that separate it from other Limoniini are: wings with vein R_2 lying far distad, beyond level of outer end of cell 1st M_2 (Fig. 6); a conspicuous pale fold in cell Cu (Fig. 6); and in males the rod-like lateral processes, one at the mesal side of each basistyle (Fig. 9). Body length varies from 7 to 13 mm; females are usually larger than males. Wing length is from 7 to 12 mm. The wings are unmarked in American species but may have a yellow or brown tinge. Body color varies from yellow to dark brown. There is no sexual difference in external morphology except for the terminal abdominal segments. Details of morphology are described by Young (1980). Only such information is presented here as is needed to clarify Figures 1-16.

Head. Lateral and ventral parts of the head largely occupied by dark compound eyes; eyes widely separated dorsally, close to each other ventrally; dorsal and lateral surfaces of head covered by long setae; antenna 16-segmented, filiform, arising on anterior part of vertex between eyes; scape cylindrical, three times as long as wide; pedicel globular, shorter, slightly wider than scape; flagellomeres subcylindrical, tapered apically, each with 4-6 verticillar setae near middle. Rostrum (Fig. 1) short, half length of head, with two conspicuous terminal labellar lobes; oral cavity formed by ventral hypopharynx and dorsal labrum; mandibles absent; maxillary galea situated below basal segment of maxillary palp.

Thorax. Neck membranous except for lateral cervical sclerite; prothorax and metathorax extremely reduced, mesothorax greatly developed (Figs. 4,5); pronotum short, convex, closely adjoining proepisternum laterally, proepimeron triangular above base of the fore coxa; mesonotum occupies nearly the entire dorsal thoracic region, distinctly divided into prescutum, scutum, scutellum and postscutellum (postnotum). Transverse suture abruptly deflected backward near mid-line and narrowly U-



FIGURES 1-4. *Dicranoptycha (D.) megaphallus*. 1, mouthparts, anterodorsal aspect. 2, distal end of hind leg, dorsal aspect. 3, distal end of hind leg, lateral aspect. 4, thorax, dorsal aspect. Abbreviations: ant-antenna, cl-claw, emp-empodium, gal-galea, hal-haltere, hyp-hypopharynx, lab-labellar lobe, lbr-labrum, mtn-metanotum, mxp-maxillary palp, pasc-parascutellum, prn-pronotum, psc-prescutum, psci-postscutellum, psf-pseudosutural fovea, rst-rostrum, scl-scutellum, scu-scutum, w-wing.

shaped (Fig. 4); prescutum large, gibbous, with a pair of pseudosutural foveae near anterolateral margins; scutum indistinctly divided medially into two portions, wings articulated beneath its lateral margins; scutellum separated from scutum by suture and with parascutellum at each side; caudal margin of the postscutellum extends over the metathorax. Mesopleuron divided by pleural suture into anterior mesepisternum and posterior mesepimeron, mesepimeron weakly divided into upper anepimeron and lower katepimeron, meron situated below mesepimeron; pleurotegrite situated at upper caudal margin of anepimeron, mesothoracic spiracles located in membranous area below prescutum and behind proepimeron. Metanotum small, beneath postscutellum, with narrow, visible lateral, transverse band; pleural suture extending from coxal process to base of haltere, dividing metapleuron into anterior metaepisternum and posterior metepimeron, metepimeron united dorsally with metanotum. Base of haltere between pleurotergite and metanotum. Metathoracic spiracle in front of base of haltere and below pleurotergite.

Wings elongate, strongly irridescent under light at certain angles. Membranous areas yellow or brown without darkened stigma, vein C darker, longitudinal veins except 2A covered with setae, wing margins fringed. Cells beyond cord long, cord located about one-third wing length from apex, fork of Rs well before cord, Rs with two branches, R_2 lying distad beyond level of outer end of cell 1st M_2 (Fig. 6); a clear, pale fold arises from near mid-length of first anal vein and runs toward and then parallel to margin of cell Cu. Haltere with cylindrical basal pedicel and bulbous, glabrous capitulum. Legs covered with numerous hairs, no distinct difference in length among legs; coxae of fore and middle legs broadly separated by mesothoracic episternum, coxae of middle and hind legs closely situated; trochanter short, densely sclerotized at distal margin with a sharp, black

spine directed inward into femur; proximal part of femur slanted, with ventral end longer than dorsal end; femur and tibia long, slender, tibia longer than femur; tarsus slender, five segmented, basitarsus the longest tarsomere, subequal to rest of tarsomeres, distal four tarsomeres darker than basitarsus; pretarsus with claws simple and a compressed, pulvilliform empodium (Figs. 2-3).

Male Abdomen. With nine evident segments (Fig. 7), first seven with spiracles, ninth segment highly modified in structure, ninth tergum and sternum fused into a nearly continuous ring with membrane at mid-ventral region, ninth tergum broadly and shallowly emarginate, tenth segment largely hidden beneath ninth tergum. Basistyles cylindrical, with two dististyles (Fig. 9), between ninth tergum and sternum, dorsal dististyle densely sclerotized, darkly pigmented, pointed at apex; ventral dististyle pale, stiferous and blunt at apex, both dististyles bend mesad, apices directed cephalad in resting position.

The male internal reproductive system includes a densely sclerotized apparatus lying mainly in the eighth and ninth abdominal segments (Fig. 10). The reproductive apparatus in *Dicranoptycha* is different from that of Tipulinae in two ways. First, it has a ventral rather than a dorsal position. Second, it does not rotate so as to give rise to the aedeagus from its anterior face as on Tipulinae; instead, the aedeagus is directed wholly caudad. Various apophyses pertaining to the aedeagus diversify greatly among the species and offer taxonomically useful characters.

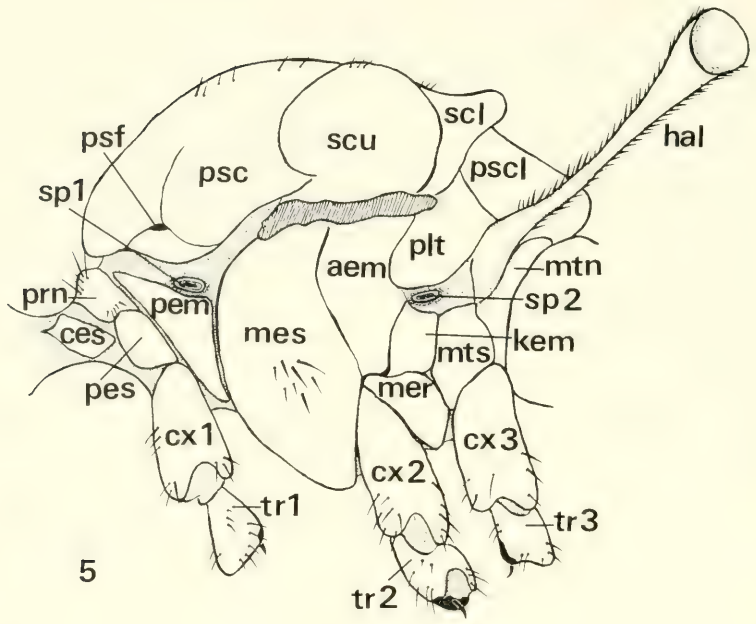
The main body of the male reproductive apparatus is the vesica, which lies ventrally in the ninth segment. The vesica (Figs. 11, 12) is a bulb-like structure with the opening of the seminal duct at its anterior end; it is connected to the aedeagus caudally. The massive, concave, dorso-ventrally depressed aedeagus protrudes from the abdominal cavity and lies in the cleft of the ninth sternum (Fig. 9,10). The aedeagal process (Fig. 12), which may be absent in some species, consists of two continuous parts attached to the aedeagus at its base. In *D. megaphallus,* the upper part is a lightly sclerotized, flat plate, darker at its posterior margin. The lower part is hook-like, attached first to the upper part at its anterior end, then the base of the aedeagus and lying medially above the aedeagus (Fig. 10). Both the aedeagus and its process are highly variable in shape among species but constant within a species.

Five immovable apodemes are attached to the vescia (Figs. 11,12). The anterior apodemes (dorsal apodeme, Starý, 1972) arise from the anterior end of the vesica and extend into the seventh segment, or in some species do not reach the seventh segment. They separate widely in *D. megaphallus* but form a single mesal apodeme in other species. The lateral apodemes are nearly uniform in structure throughout the genus. The upper part of each lateral apodeme extends upward and backward and forms the external, pale, rod-like, lateral process (Alexander, 1926) adjacent to the mesal base of each basistyle. The apex of the lateral process is somewhat triangular in cross-section and gives the impression of having three flat sides. The lateral process has been interpreted as tergal arm (Alexander, 1940), interbasal process (Alexander, 1926) and interbase (Starý, 1972). The lateral processes are connected dorsally by means of a narrow brace, or dorsal bridge, over the top of the vesica. The lower parts of the lateral apodemes extend ventrally around the vesica and meet at its mid-ventral line, where they fuse and form a well developed keel-shaped ventral apodeme which is vestigial in some species.

Female Abdomen. With ten visible segments (Fig. 8); first seven unmodified, last three shortened to form ovipositor; eighth tergum much reduced, eighth sternum well developed, projected backward below ninth and tenth segments, forming pair of basally fused hypovalves (Fig. 13); hypovalve concave on inner surface forming pocket with gonopore at anterior base; hypovalve with eight to twelve stiff bristles on inner dorsal edge; ninth tergum about same size as eighth, narrow lateral arms of ninth deflected caudad and joining ninth sternum, ninth sternum concealed by eighth sternum.

In *D. megaphallus,* the only sclerotized, externally visible reproductive apparatus that has an internal connection is the genital furca (Figs. 15,16), or fused redimentary gonapophyses (Snodgrass, 1903). It is found in the membranous area of the eighth sternum, directly below the aperture of the bursa copulatrix. The genital furca has its base above the oviduct at the base of the hypovalves, and its arms fuse with the bases of the ninth sternum (second vavulae). The tenth segment is elongated and tapered caudad. Strong blade-like cerci arise from the caudal margin of the tenth tergum. The shape of the cerci is used in this study as a characteristic to subdivide the genus into three species groups. The tenth sternum is only lightly sclerotized and bears long stiff setae at its caudal margin.

Two major internal reproductive structures can be seen through the side of a specimen cleared in potassium hydroxide. The common oviduct (Fig. 15) leads cephalad from the gonopore along the floor of the eighth segment to the bases of the hypovalves. In *D. megaphallus*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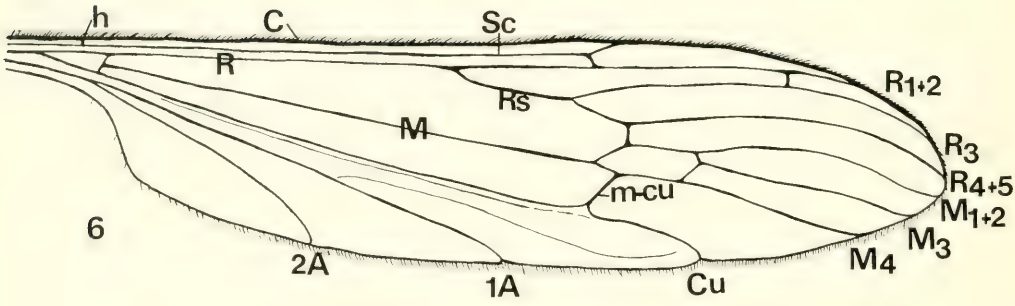
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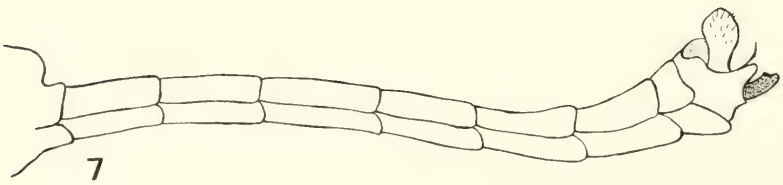

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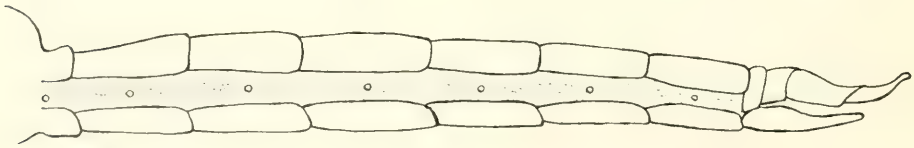

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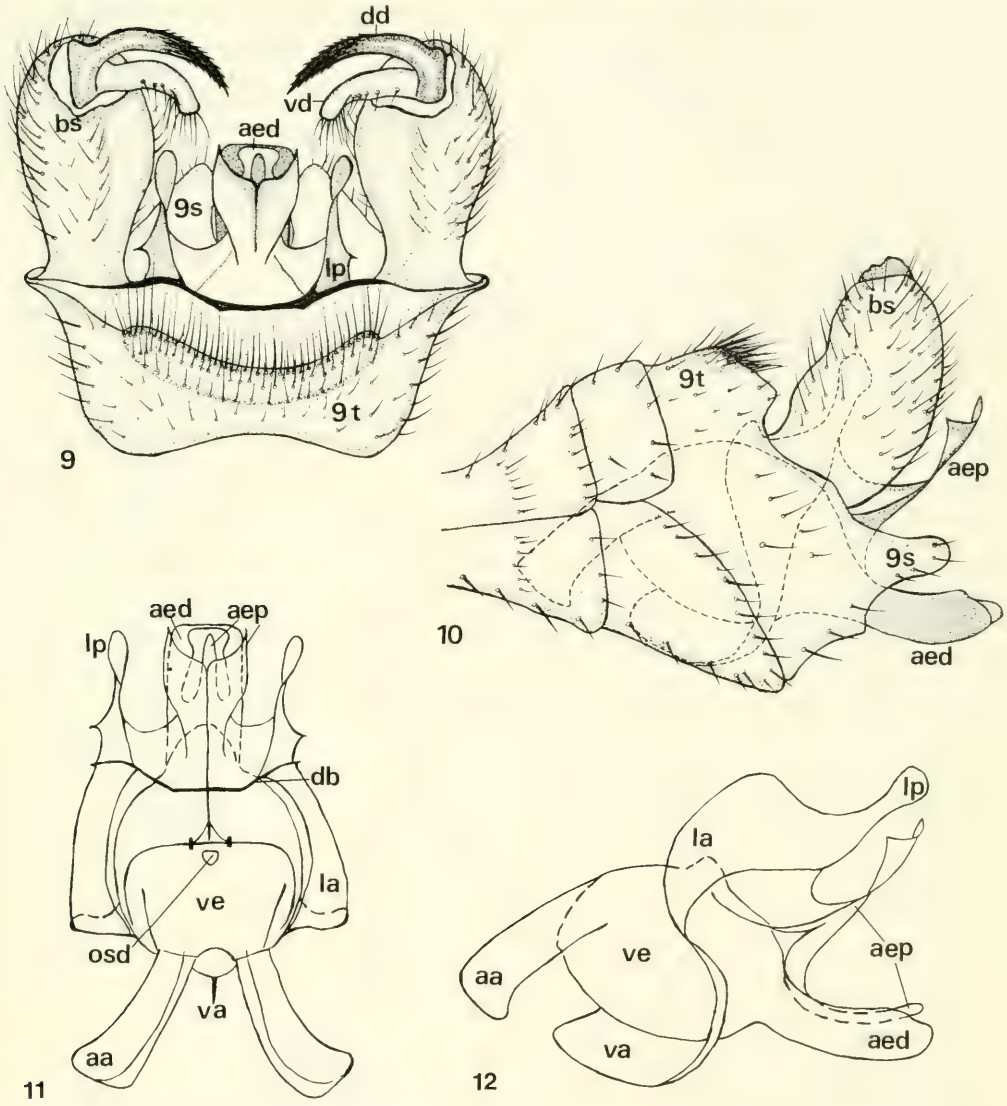
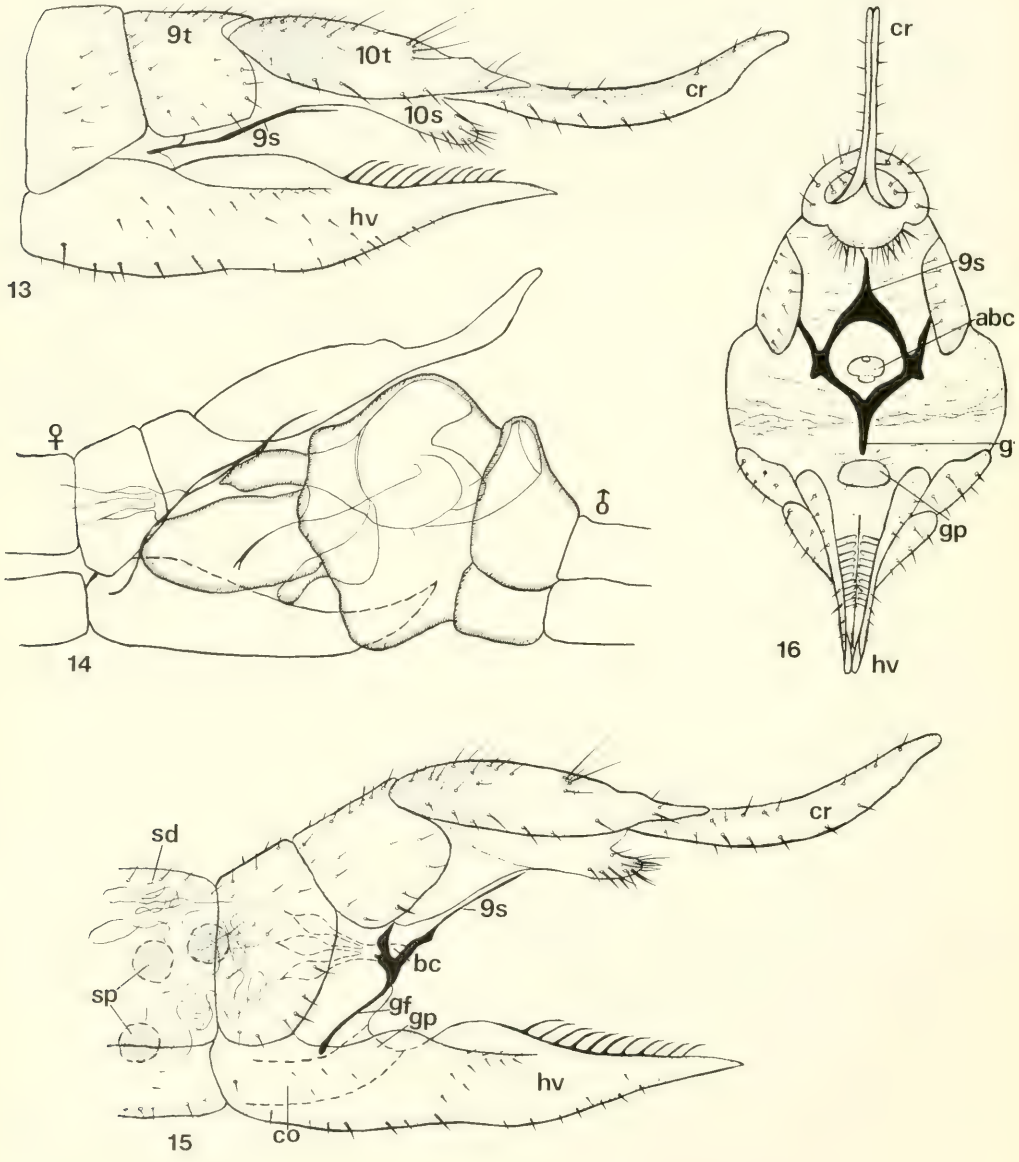


FIGURES 9-12. *Dicranoptycha (D.) megaphallus,* male hypopygium. 9, dorsal aspect. 10, left lateral aspect. 11, internal reproductive ystructures, dorsal aspect. 12, left lateral aspect. Abbreviations: aa-anterior apodeme, aed-aedeagus, aep-aedeagal process, bs-basistyle, db-dorsal bridge, dd-dorsal dististyle, la-lateral apodeme, lp-lateral process, osd-opening of seminal duct, s-sternum, t-tergum, va-ventral apodeme, vd-ventral dististyle, ve-vesica.

← FIGURES 5-8. *Dicranoptycha (D.) megaphallus.* 5, thorax, left lateral aspect. 6, wing. 7, male abdomen, left lateral aspect. 8, female abdomen, left lateral aspect. Abbreviations: A-anal veins, aem-anepimeron, C-costa, ces-cervical sclerite, cx-coxa, Cu-cubitus vein, h-humeral crossvein, hal-haltere, kem-katepimeron, M-media veins, m-cu-median cubital crossvein, mer-meron, mes-mesepisternum, mtn-metanotum, mts-metepisternum, pem-proepimeron, pes-proepisternum, plt-pleurotergite, prn-pronotum, psc-prescutum, pscl-postscutellum, psf-pseudosutural fovea, R-radius veins, Rs-radial sector, Sc-subcosta vein, scl-scutellum, scu-scutum, sp-spiracle, tr-trochanter, w-wing.

(Fig. 15), the short bursa copulatrix is formed by fusion of three greatly convoluted spermathecal ducts, each duct having a sac-like enlargement near the aperture of the bursa copulatrix and connecting to a spherical, darkly sclerotized spermatheca at its anterior end. The spermathecae is oval in some other species.

When females are examined from the postero-ventral aspect (Fig. 16), the ninth sternum (fused valvulae), genital furca, and aperture of the bursa copulatrix can be seen clearly. The first two parts are densely sclerotized and nearly uniform throughout the genus. The aperture of the bursa copulatrix is in the membranous area



FIGURES 13-16. *Dicranoptycha (D.) megaphallus*. 13, female hypopygium, left lateral aspect. 14, detail of hypopygia of male and female in mating. 15, female hypopygium, left lateral aspect showing internal reproductive structures. 16, female hypopygium, postero-ventral aspect. Abbreviations: abc-aperture of bursa copulatrix, bc-bursa copulatrix, co-common oviduct, cr-cercus, gf-genital furca, gp-gonopore, hv-hypovalve, s-sternum, sd-spermathecal duct, sp-spermatheca, t-tergum.

surrounded by the ninth sternum and genital furca. In *D. megaphallus* this aperture is wide at the level of the membrane but narrowed anteriorly, thus appearing as a rounded depression. In some other species, an additional structure, the receptacle for the male's aedeagal process, can be seen in this membraneous area. The slightly sclerotized receptacle for the aedeagal process is situated below the aperture of bursa copulatrix. The wall of this receptacle can be seen extended inward when one examines a specimen cleared in potassium hydroxide. The form of the receptacle varies among species and it is especially well developed in species in which the male has a complicated aedeagal process, such as *D. nigripes, D. pallida, D. tigrina.* The gonopore can be seen at the base of hypovalve, below the genital furca.

External Morphology of Immatures

The only published reference to immature stages of *Dicranoptycha* is that of Alexander (1919b), who recorded the larval habitat and morphology of two species, *D. pallida* (as *D. winnemana,* corrected by Alexander, 1926) and *D. minima.* Descriptions of immature stages of a third species, *D. megaphallus,* are contained in this section.

Egg. Matured egg oval, about 0.38 mm in length and 0.25 mm in width, soft and buff colored when laid, soon harder and brown. Chorion appears rough, covered with hexagonal protuberances (Fig. 17).

Last Instar Larva. Length 22-24 mm, dextrosinistral and dorsoventral diameters both 1.0-1.1 mm. Body form (Fig. 22) terete, strikingly elongate and vermiform. Integument transparent in life, white after preservation in alcohol. Body glabrous except for creeping welts consisting of 25-30 transverse rows of microscopic hooks on ventral surfaces of abdominal segments 2-8. Spiracles on pleura of abdominal segments 1-7, each with one small darkened sclerotized plate posterior to its sclerotized opening (Fig. 23).

Figure 17. Egg of *Dicranoptycha (D.) septemtrionis.*

Head capsule (Figs. 18, 19, 20) sclerotized. Antennae two-segmented, inserted above bases of mandibles; basal segment elongate and cylindrical, about three times as long as basal width; apical segment slender, tapering apically, about half length of basal one. Labrum three-lobed (Fig. 18) with minute hairs anteriorly. Frontal suture distinct, darkly sclerotized; clypeus broad, pale. Mandible (Fig. 20) of cutting-chewing type, strongly sclerotized, with three, small, blunt teeth at apex and large molar area. Maxilla (Fig. 19) with sclerotized cardo and stipes, deeply cleft anteriorly between subequal inner lacinia and outer maxillary palp. Hypostomal bridge broad, heavily sclerotized, deeply cleft behind, with three bluntly rounded teeth. Hypopharynx with two sclerotized arms and rounded central part covered with microscopic tubercles.

Spiracular disk (Fig. 21) with four fleshy lobes, a lateral pair and a ventral pair; lateral lobes slightly longer than ventral ones. Spiracles small, fuscous brown with blackish centers, separated by distance slightly more than transverse width of a spiracle. Inner face of lateral lobe with brown mark of which pointed proximal end curves up toward spiracle. Ventral lobe bears smaller brown mark near base. Inverted Y-shaped brown mark on disk between lateral lobes. Anal gills inconspicuous, forming ring-like protuberance around anus.

The larva of *Dicranoptycha megaphallus* resembles that of *D. pallida,* differing most conspicuously in the structure of the hypostomal bridge. It lacks the basilateral notch in each lateral tooth.

Pupa. Length from cephalic crest to tip of abdomen 9.5-10 mm in male, 10-11 mm in female; diameter about 1.8 mm. Form (Figs. 24,25) terete, gradually tapering from base of wing pads to slender cauda. Pupa pale when young, older pupa with brown thorax and light yellow abdomen; structures of adult clearly visible through cuticle of older pupa. Pronotal respiratory horn very small, a tiny tubercle when viewed anteriorly or dorsally. Tips of wing sheaths reaching mid-length of third abdominal segment. Apices of sheaths of all tarsi reaching about end of fifth abdominal segment. Abdomi-

nal segments each subdivided into four transverse ridges dorsally and three ventrally, each ridge bearing transverse band of microscopic hooks. Spiracles on pleural regions of segments 2-7, behind each a patch of microscopic hooks. Cauda of both sexes with two schlerotized hooks curved dorsocephalad; hooks large and conspicuous in male (Fig. 26), smaller and projecting from near apices of cercal sheaths in female (Fig. 27). Male with additional pair of small projections near dorsolateral margin of ninth tergum; female hypovalves slightly larger than cercal sheaths.

BIONOMICS

ADULT. In North America adults of *Dicranoptycha* usually emerge in spring, but a few species emerge in summer or autumn. All species appear to have one generation a year. At the beginning of the emergence period, males are more abundant than females, and toward the end the females are more numerous. When the adults are raised in the laboratory, their life span is about six days; survival would probably be shorter in natural habitats. In Kansas, the season of flight for each species lasts about three weeks. The remainder of the year is passed as immature stages in the ground.

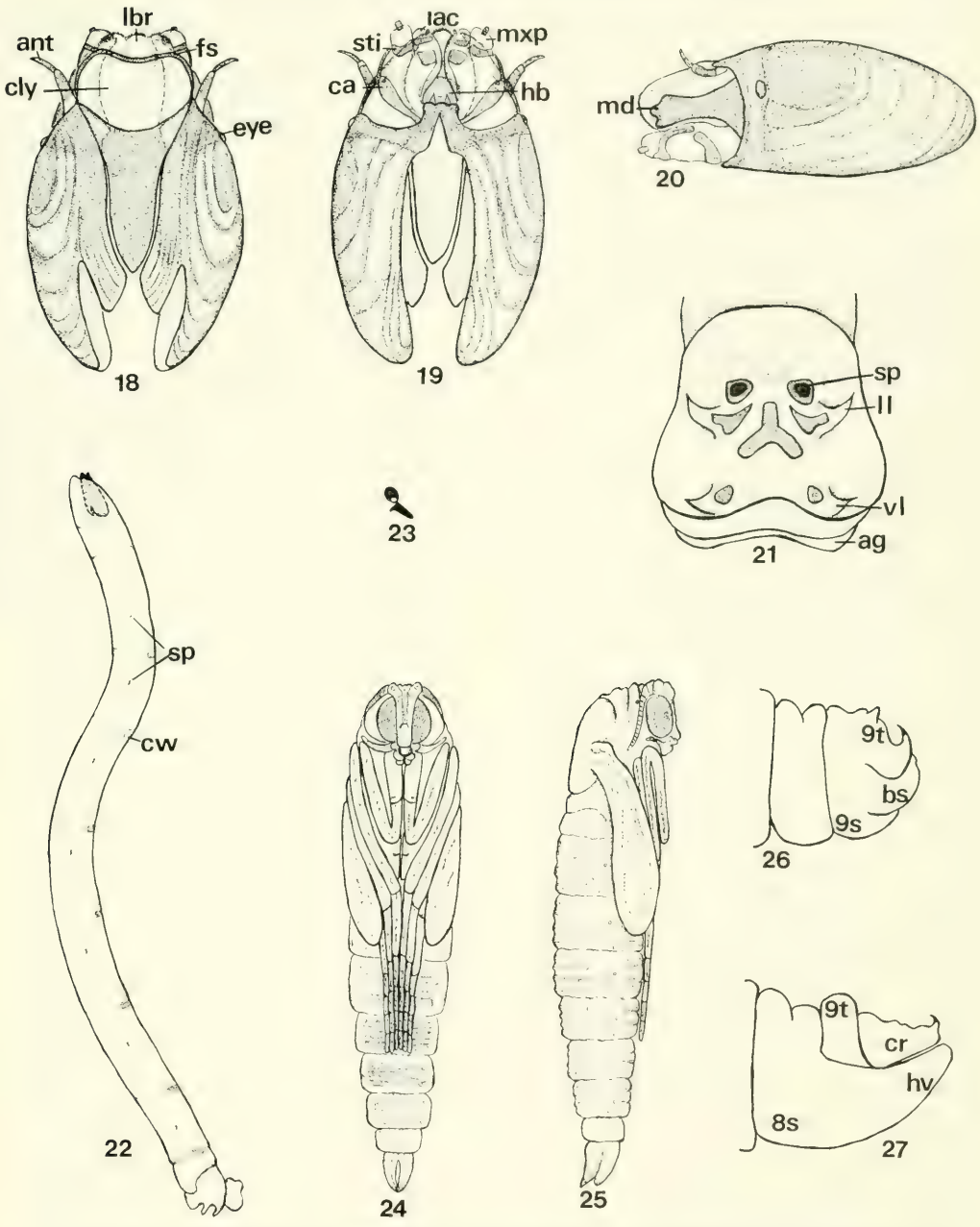
Net collecting indicates that adults occur in humid to relatively dry open woodlands, locally restricted to the undergrowth stratum of shrubs and herbs. In Kansas, Missouri, Illinois or other western parts of the eastern range of the genus, *Dicranoptycha* is associated with poison ivy, nettle, jewelweed, and buckbrush shaded by oak-hickory forests. Farther to the east, especially along the lower slopes of the Appalachians, the flies are associated with *Eupatorium,* bugbane *(Cimicifuga),* jewelweed, poison ivy and other undergrowth herbs of mixed deciduous forests of oak, maple and tulip tree. Species with a western distribution are most likely to be found in the undergrowth of evergreen forests but can also be found in the drier chaparral.

Adults usually stand upright, with the body elevated parallel to the upper surfaces of leaves and the wings folded flat over the back. The up-and-down bobbing motion seen in many other genera is inconspicuous. They are sluggish flies; when disturbed they fly about two meters before they alight. They apparently do not shift into higher or lower strata in response to diurnal changes in temperature, light intensity, humidity or combinations of these factors. Aggregations of individuals occur in the more favorable habitats, and in such places mating pairs can be found at any time of the day.

The main functions of the adults are mating and egg-laying. Feeding is less important, and probably water is the most pressing need. In the morning, adults can be found slowly walking on the upper surfaces of leaves, exhibiting rapid movements of the maxillary palpi in search of water. I have observed the adults drink from dewdrops. Sugar water was offered as food for adults kept in laboratory. Oviposition was not observed in the field. Egg-laying appears to take place at night when females can also be found walking or resting on the ground of the daytime habitats. In the laboratory, eggs were laid singly and scattered in the soil surface. In the natural habitat, eggs probably are laid in the leaf litter.

Seven species of *Dicranoptycha* were recorded from the vicinity of Lawrence, Kansas, where most of my biological observations were made. *D. megaphallus* is the first species to appear in May, followed by *D. elsa* and *sobrina* in June, *D. pallida* in July, and then the fall species, *D. septemtrionis, tigrina,* and *minima,* in September. *D. megaphallus* will serve as a representative of the genus.

IMMATURE STAGES. Larvae of *D. megaphallus* can be found in the soil of the habitat where the adults occurred earlier in the season. Larvae occur within two or three millimeters of the surface of the soil after the leaf litter has been removed. They are active and move freely through the soil without established burrows. The shiny, glassy appearance suggests that the body is probably covered by some secretion. Larvae feed on decayed plant material in the ground. In rearing dishes, all the feces are deposited on the top of the soil. The number of larval stadia is probably four but was not verified. In the wild, small, early stage larvae of *D. megaphallus* can be collected in November, and fully grown



FIGURES 18-27. *Dicranoptycha (D.) megaphallus,* immature stages. 18, head capsule of last instar larva, dorsal aspect. 19, ventral aspect. 20, left lateral aspect. 21, cauda of last instar larva. 22, last instar larva, left lateral aspect. 23, spiracle of last instar larva. 24, pupa, ventral aspect. 25, pupa, right lateral aspect. 26, cauda of male pupa. 27, cauda of female pupa. Abbreviations: ag-anal gill, ca-cardo, cly-clypeus, cr-cercus, cw-creeping welt, fs-frontal suture, hb-hypostomal bridge, hv-hypovalve, lac-lacinia, lbr-labrum, ll-lateral lobe, md-mandible, mxp-maxillary palp, s-sternum, sp-spiracle, sti-stipes, t-tergum.

ones in March. Judging from these collecting data, eggs probably hatch in May, a week or two after oviposition; larvae reach the fourth instar by fall, overwinter, and resume feeding in spring until pupation occurs in late April.

The mature larvae make horizontal tunnels about three millimeters under the soil surface. At the end of its tunnel the larva makes a small cell for pupation. The inside of the cell is smooth but without silk. The earthen walls of the cell are cemented, probably with saliva, and are quite firm and thick. The cell itself (with adhering earth particles) can be easily sorted out from loose soil. The cell is open at one end, slightly over one half the length of the mature larva, but large enough for the larva to move freely and make turns. At this stage larvae decrease in length by more than one-third. The duration of the pupal stage is about ten days. The adult emerges at night, pushing the earth from the open end of the pupal cell and freeing itself from the pupal skin. Usually the posterior two thirds of the pupal skin remains in the cell. Newly emerged adult flies rest on the ground before the first flight.

MATING BEHAVIOR

Several species of *Dicranoptycha* have been observed to form mating pairs at nearly any time of day during the peak season of adult emergence. No swarming behavior is known for species of this genus. In no case did I find mating to involve a teneral female; I therefore assume that males do not actively search for newly emerging females on the ground, as in several other genera. Direct body contact between two flies plays an important role in activity leading to copulation. Presumably, adults are attracted to the same shaded places in undergrowth vegetation and physical contact may occur in such places. Whether sexual or aggregation pheromones are involved in bringing the males and females together is unknown.

During mating, both flies stand high, with the body elevated and orientated parallel to the substratum, usually the upper surface of a leaf in low undergrowth. They face in opposite directions, the female maintaining her normal body position, while the male's abdomen turns 180 degrees and grasps the female genital segments from behind. The connection between male and female is secured by the male grasping the lateral membranous areas of the female's eighth segment with his dorsal and ventral dististyles, and by the insertion of the female's hypovalves into the male's genital chamber against the hidden tenth segment.

A distinct change from the ordinary position of the male internal reproductive structures can be observed during copulation. As a lateral view (Fig. 14) shows, the vesica rotates about 45 degrees, so that the anterior apodemes press against the ninth sternum. The ridge formed by the ventral apodeme pushes the cerci away from the hypovalves and exposes the aperture of the bursa copulatrix, where the male aedeagus is introduced. Although in some species the aedeagal process and the lateral processes do not perform any obvious function in mating, in *D. megaphallus* the aedeagal process is brought into close proximity to the gonopore of the female (Fig. 14).

When a resting pair is disturbed, they fly in a more or less straight descending line, with the male flapping his wings but being carried by the female until she alights on some object. The duration of mating is unknown. One mating pair of *D. megaphallus* reared in the laboratory remained in copulation for about nine hours. Another pair of the same species was collected *in copula* in their natural habitat and remained together for eight hours after being brought into the laboratory.

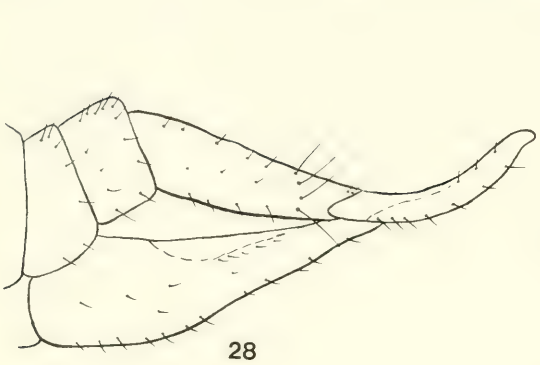
SUBGENUS *DICRANOPTYCHA*

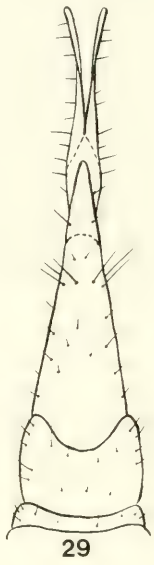
All North American species belong to the subgenus *Dicranoptycha,* in which three well-defined species groups can be recognized on the basis of the female cerci. The *germana* group consists of *D. acanthophallus, australis, byersi, elsa, germana, megaphallus, minima, nigripes, pallida, septemtrionis, sobrina, spinifera, tennessa, tigrina,* and *winnemana.* Females of this group have the cerci long and slender, blade-like, narrowly rounded or pointed apically, longer than or subequal to the length of the tenth tergum.

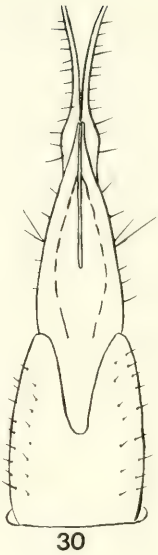
The cerci and tenth tergum are evenly covered by uniformly short setae, except ten to twelve longer ones near the posterior end of the tenth tergum (Figs. 28, 29, 30; these figures were drawn from a dried specimen, in which the cerci appear separated from each other in both dorsal and ventral aspects; in alcoholic specimens they are contiguous along the median line). The *melampygia* group includes *D. melampygia, nigrogenualis, occidentalis, quadrivittata, spinosissima* and *stenophallus.* The cerci of females of this group are short and broad, spatulate, shorter than the tenth tergum. The ventral margins of the basal half of the cerci flare out laterad. Long and dense setae form a partial whorl around the posterior end of the tenth tergum and along the flared margins of the cercal bases (Figs. 31, 32, 33; figures drawn from dried specimens). The *linsdalei* group contains only *D. linsdalei,* in which the cerci (Figs. 34, 35, 36) are very short, about one half the length of the tenth tergum. The bases of the cerci are fused together. Setae are evenly distributed on both the tenth tergum and cerci, with longer ones around the posterior end of tenth tergum. *D. laevis* is ungrouped in this study because the female is unknown to me.

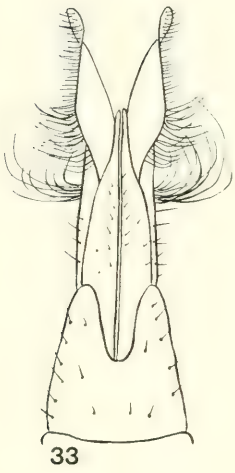
Key to Adult Males of North American *Dicranoptycha*

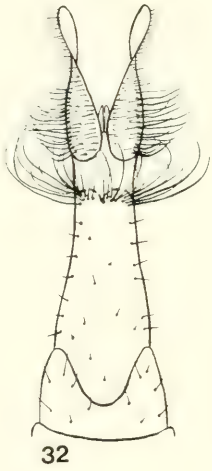
1. Small species; body length about 6.5 mm or less 2
— Larger species; body length from 7 to 11 mm 4
2. Dorsal dististyle denticulate on outer curvature (Fig. 121). . . *linsdalei*
— Dorsal dististyle smooth on outer curvature (Figs. 61,125). 3
3. Ventral dististyle broadly expanded; aedeagus without processes (Figs. 61, 62) . . . . . *minima*
— Ventral dististyle not expanded; aedeagus with two conspicuous, blade-like aedeagal processes, recurved posteriorly to fuse with dorsum of aedeagus (Figs. 125, 126). . . . . *laevis*
4. Ninth sternum with short spines on posterior margin; vein 2A with setae (Figs. 53, 54) . . . . . *germana*
— Ninth sternum without spines on posterior margin; vein 2A without setae 5
5. Abdominal sterna bicolored 6
— Abdominal sterna unicolored. 8
6. Sterna each with anterior dark transverse band; aedeagus with undivided flattened aedeagal process (Figs. 77, 78) . . . . . *sobrina*
— Sterna each with dark transverse band between two light colored bands; aedeagus with two-branched aedeagal process (Figs. 65, 89) . . . 7
7. Body color reddish yellow; secondary branch arises from about midlength of aedeagal process (Figs. 65, 66) . . . . . *nigripes*
— Body color grayish brown; secondary branch arises from near tip of aedeagal process (Figs. 89, 90). . . . . *tigrina*
8. Lateral process with two arms (Figs. 113, 114). . . . . *spinosissima*
— Lateral process with single arm . . . 9
9. Lateral process with flange along outer margin of apical half (Figs. 97, 101, 105). 10
— Lateral process without flange . . . 12
10. Aedeagal process with rod-like lower part hanging behind aedeagus (Figs. 101, 102) . . . . . *nigrogenualis*
— Aedeagal process without lower part (Figs. 98, 106) 11
11. Body color grayish yellow; abdominal segments 7 and 8 forming darkened subterminal ring (Figs. 105, 106). . . . . *occidentalis*
— Body color brown; abdomen without subterminal darkened ring (Figs. 97, 98). . . . . *melampygia*
12. Body color yellow or brownish yellow 13
— Body gray or dark brown 17
13. Dorsal dististyle smooth on outer curvature; tips of femora and tibiae darkened (Figs. 69, 70) . . . . . *pallida*
— Dorsal dististyle denticulate on outer curvature; leg segments unicolorous 14
14. Abdominal segments 6 and 7 forming darkened subterminal rings; aedeagus conspicuous, dorso-ven-

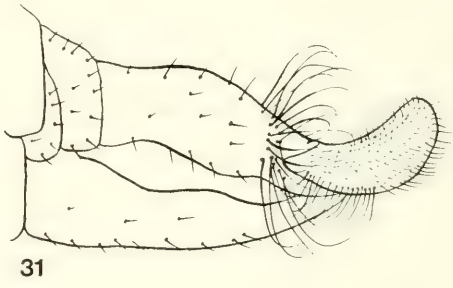


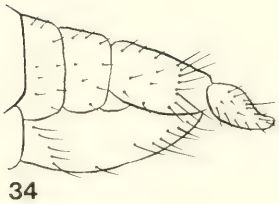


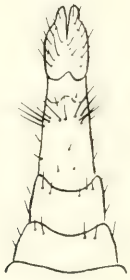












FIGURES 28-30. *Dicranoptycha (D.) megaphallus,* female hypopygium showing typical cerci of germana group. 28, left lateral aspect. 29, dorsal aspect. 30, ventral aspect.

FIGURES 31-33. *Dicranoptycha (D.) melampygia,* female hypopygium showing typical cerci of melampygia group. 31, left lateral aspect 32, dorsal aspect. 33, ventral aspect.

FIGURES 34-36. *Dicranoptycha (D.) linsdalei,* female hypopygium. 34, left lateral aspect, 35, dorsal aspect. 36, ventral aspect.

trally flattened (Figs. 57, 58) . . . . . *megaphallus*
— Abdominal segment 7 forming darkened subterminal ring; aedeagus not as above 15
15. Aedeagal process with rod-like upper part, lower part enlarged and curved around three-branched aedeagus (Figs. 93, 94). . . *winnemana*
— Aedeagal process with flattened, broad upper part, lower part rod-like hanging behind short aedeagus (Figs. 42, 118) 16
16. Upper part of aedeagal process evenly rounded toward posterior margin in dorsal apsect (Figs. 117, 118) . . . . . *stenophallus*
— Upper part of aedeagal process abruptly rounded at about one-third of posterior end in dorsal aspect (Figs. 41, 42) . . . . . *australis*
17. Wings with a distinct brown seam along entire length of vein Cu . . . 18
— Wings without a brown seam along vein Cu 20
18. Aedeagus curved upward, with spines around edges (Figs. 45, 46) . . . . . *byersi*
— Aedeagus straight, with spines only at apex (Figs. 38, 82). 19
19. Aedeagus with spines at apex; lateral process as long as basistyle (Figs. 81, 82) . . . . . *spinifera*
— Aedeagus with tiny spines on inner apical surface; lateral process about half length of basistyle (Figs. 37, 38). . . . . *acanthophallus*
20. Aedeagus with two finger-like projections at posterior end; lateral process with pointed apex (Figs. 109, 110). . . . . *quadrivittata*
— Aedeagus without finger-like projections; lateral process with rounded apex. 21
21. Aedeagal process with upper part pale; lower part rod-like, bent ventrad; aedeagus with hook-like projection at posterior end (Figs. 73, 74). . . . . *septemtrionis*
— Aedeagal process with upper part darker at posterior margin; lower part rod-like, straight, aedeagus without projection. 22
22. Rod-like lower part of aedeagal process extending beyond aedeagus (Figs. 49, 50) . . . . . *elsa*
— Rod-like lower part of aedeagal process not extending beyond aedeagus (Figs. 85, 86). . . . . *tennessa*

Key to Adult Females of North American *Dicranoptycha*

1. Cerci short, broad, shorter than tenth segment; tenth tergum with score of long setae near posterior margin; flies of western North America. 2
— Cerci long, slender, subequal to or longer than tenth segment; tenth tergum with about 10-12 long setae near posterior margin (Figs. 28, 29, 30); flies of eastern North America . . . . . *germana* group 3
2. Cerci separate at bases and with long setae at slightly flared bases (Figs. 31, 32, 33); hypovalve with setae along inner dorsal edge . . . . . *melampygia* group. 17
— Cerci very short, fused at bases (Figs. 34, 35, 36), without long basal setae; hypovalve without setae on inner dorsal edge (Figs. 123, 124) . . . . . *linsdalei* group . . . . . *linsdalei*
3. Vein 2A with setae; postero-ventral aspect of external reproductive structure as in Fig. 56 . . . . . *germana*
— Vein 2A without setae 4
4. Abdominal sterna bicolored 5
— Abdominal sterna unicolored. 7
5. Sterna with dark transverse band at anterior part; postero-ventral aspect of external reproductive structure as in Fig. 80. . . . . *sobrina*
— Sterna with dark transverse band between two light colored bands. . . 6
6. Body color reddish yellow; wing with yellow tinge; postero-ventral aspect of external reproductive structure as in Fig. 68 . . . . . *nigripes*
— Body color grayish brown; wing with gray tinge; postero-ventral aspect of external reproductive structure as in Fig. 92 . . . . . *tigrina*
7. Small species; body length about

6.5 mm or less; postero-ventral aspect of external reproductive structure as in Fig. 64 . . . . . *minima*
— Larger species; body length about 7-12 mm 8
8. Body color yellow or brownish yellow 9
— Body color gray or dark brown . . 12
9. Ninth sternum and genital furca separated (Figs. 72, 96) 10
— Ninth sternum and genital furca fused (Figs. 44, 60) 11
10. Legs yellow, tips of femora and tibiae darkened; receptacle for aedeagal process beneath aperture of bursa copulatrix (Fig. 72) . . *pallida*
— Legs yellow, without darkened tips on femora and tibiae; receptacle for aedeagal process beneath and around sides of aperture of bursa copulatrix (Fig. 96) . . . . . *winnemana*
11. Verticils long, about 2.5 times length of their respective flagellomeres; ninth sternum with angularly bent sides (Fig. 44). . . . *australis*
— Verticils about twice length of their respective flagellomeres; ninth sternum with evenly rounded sides (Fig. 60). . . . . *megaphallus*
12. Body color gray 13
— Body color dark brown. 14
13. Abdomen with darker terga and lighter sterna; body shorter than 10 mm; postero-ventral aspect of external reproductive structure as in Fig. 76 . . . . . *septemtrionis*
— Abdomen uniformly gray; body longer than 10 mm; postero-ventral aspect of external reproductive structure as in Fig. 88 . . . . . *tennessa*
14. Wings without a brown seam along vein Cu; postero-ventral aspect of external reproductive structure as in Fig. 52. . . . . *elsa*
— Wings with a distinct dark brown seam along vein Cu. 15
15. Ninth sternum and genital furca fused (Fig. 40) . . . . . *acanthophallus*
— Ninth sternum and genital furca separate (Figs. 48, 84) 16
16. Sides of ninth sternum straight (Fig. 48) . . . . . *byersi*
— Sides of ninth sternum rounder at basal half (Fig. 84) . . . . . *spinifera*
17. Ninth sternum and genital furca separated (Figs. 104, 116). 18
— Ninth sternum and genital furca fused 19
18. Body color dark brown; receptacle for aedeagal process present, beneath the aperture of bursa copulatrix (Fig. 104) . . . . . *nigrogenualis*
— Body color brown; receptacle for aedeagal process absent (Fig. 116) . . . . . *spinosissima*
19. Body color dark brown; postero-ventral aspect of external reproductive structure as in Fig. 100 . . . . . *melampygia*
— Body color gray or yellow 20
20. Body color gray; aperture of bursa copulatrix T-shaped (Fig. 112) . . . . . *quadrivittata*
— Body color yellow; aperture of bursa copulatrix rounded 21
21. Receptacle for aedeagal process present, beneath aperture of bursa copulatrix (Fig. 120) . . . . *stenophallus*
— Receptacle for aedeagal process absent (Fig. 108) . . . . . *occidentalis*

THE *GERMANA* GROUP

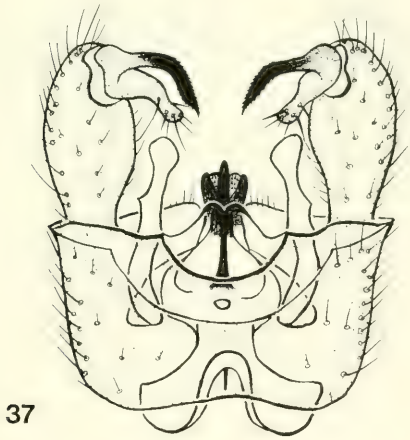
Dicranoptycha (Dicranoptycha) acanthophallus Alexander

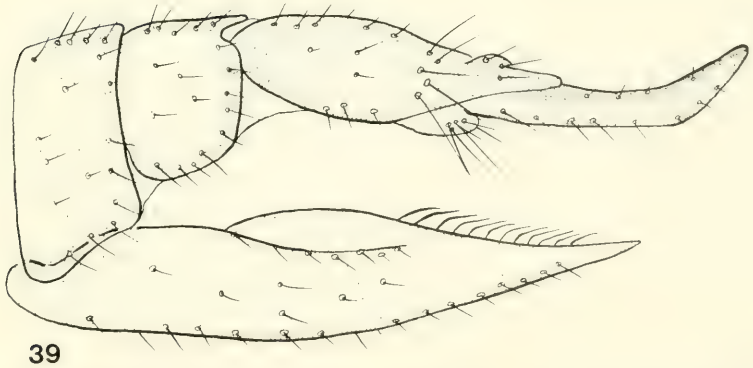
Dicranoptycha acanthophallus Alexander, 1940, Amer. Midland Nat. 24:621.

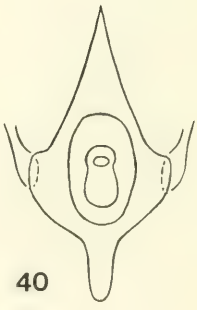
TYPES. Holotype, male, Gregory Ridge Trail, Blount County, Tennessee, 17 June 1939, C. P. Alexander. Allotype, same data as holotype. Paratypes, seven females, same data as holotype, one male and two females from Greenbrier Cove, Sevier County, Tennessee, 23 June 1940, C. P. Alexander. Holotype, allotype and nine paratypes are in the Alexander collection, NMNH. One female paratype is in UMMZ. The holotype and male paratype are mounted on microscope slides.

TAXONOMIC CHARACTERISTICS. Basic coloration dark brown. Male body length 8.5-9 mm, wing 10.5 mm. Female body length 9.5-11 mm, wing 12 mm. *Head* ashy gray, with one row of black bristles around each eye. Rostrum brown with slight gray pollinosity, palpi blackish brown. Antennal scape and pedicel tawny, flagellomeres dark brown. Verticils about twice the length of their respective flagellomeres. *Thorax* dark

brown with dense gray pollinosity on pleura. Mesonotum dark gray, prescutal stripes only weakly differentiated. Pseudosutural foveae polished black. Wings with yellowish brown tinge; a distinct brown seam along entire length of vein Cu; setae on all longitudinal veins except 2A. Halteres pale. Coxae yellow, pruinose at bases, trochanters yellow with black spot at ventral distal end, femora and tibiae yellow to testaceous with brown tips, basitarsi testaceous, tarsomeres dark brown. *Abdomen* slightly darker than thorax. Male hypopygium (Fig. 37) brownish yellow. Dorsal dististyle evenly curved and narrowed toward apex, abruptly narrowed only at tip and terminating in a straight spine; apical half blackened; spinules on apical half. Ventral dististyle strongly expanded at base, constricted before dilated apex. Male genitalia (Fig. 38) with vesica oval. Lateral process pale, expanded and rounded apically, with a sharp lateral point near base. Anterior apodemes slender at point of fusion with vesica, widening to broadly rounded apices. Upper part of lateral apodemes broadly expanded. Ventral apodeme keel-like, well developed. Aedeagus short and broad; about a dozen short, erect spines on dorsal concave surface at apex (visible by compound microscope). Aedeagal process small; upper part flat, plate-like, with two darker rounded lobes at posterior margin, connected beneath margin to hook-like lower part curved downward above aedeagus, its apex slightly exceeding tip of aedeagus. Female genitalia (Fig. 39) of *germana* form. Cerci about same length as tenth tergum, evenly narrowed toward tip, upturned a little beyond mid-length. Hypovalves reaching slightly beyond mid-length of cerci; twelve setae on inner dorsal edge of each hypovalve. Postero-ventral aspect of external reproductive structures as in Fig. 40.







FIGURES 37-40. *Dicranoptycha (D.) acanthophallus*. 37, male hypopygium, dorsal aspect. 38, left lateral aspect with external skeleton removed. 39, female hypopygium, left lateral aspect. 40, postero-ventral aspect.

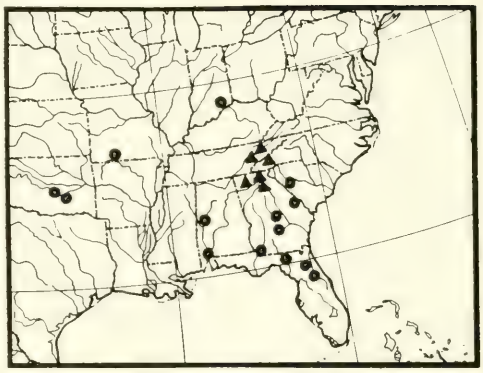
COMPARATIVE NOTES. The general appearance of *Dicranoptycha acanthophallus* is similar to that of *byersi* and *spinifera,* while the male genitalia are somewhat similar to those of *elsa.* J. S. Rogers recorded in his study notes that "The Virginia specimens fit Alexander's description of male genitalia (as well as all other details) while the Ohio specimen is nearest the figure that accompanies description." After examining all these specimens, I have determined that those from Ohio are *D. elsa* and those from Virginia are *spinifera.* This confusion has resulted in most museum specimens determined as this species being actually *D. spinifera,* while most specimens of *acanthophallus* were found to be incorrectly determined as *elsa. D. acanthophallus* differs from *elsa* mainly by its generally shorter body and wings and darker color, the dark tips on the femora, the distinct brown seam along vein Cu, and in the male the shorter hook on the lower part of the aedeagal process, which in *elsa* extends far beyond the tip of the aedeagus. The similarities among *D. acanthophallus, byersi* and *spinifera* are discussed under *byersi.*

GEOGRAPHIC AND SEASONAL DISTRIBUTION. *D. acanthophallus* is known only from the southern Appalachian Mountains of Tennessee, North Carolina, and Georgia (Map 1). My collection records show that this species is most often taken with *D. byersi* and *spinifera* in valleys of 2000-3000 feet altitude, where woods of mixed tulip trees, oaks, maples, and white pine occur and undergrowth is jewelweed, greenbriar, and May-apple. All of the records for this species are in late May and June, suggesting that this is a late spring species. The captures indicate that the peak of emergence falls about the first week of June.

Summary of distribution: Georgia - Murray Co., 28 May; Towns Co., 30 May; White Co., 20 May. North Carolina - Haywood Co., 31 May. Tennessee - Blount Co., 17 June; Sevier Co., 23 June.

Dicranoptycha (Dicranoptycha) australis Alexander

Dicranoptycha australis Alexander, 1926, Psyche, 33: 55.



MAP 1. Known distribution of *Dicranoptycha acanthophallus* (triangles) and *D. australis* (circles). Each symbol indicates one or more county records.

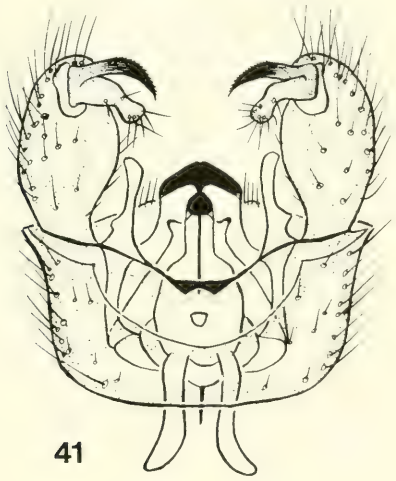
TYPES. Holotype, male, Gainesville, Alachua County, Florida, 15 April 1922, J. S. Rogers. Allotype, Ocmulgee Valley, Bibb County, Georgia, 3 June 1923, J. S. Rogers. Paratypes, four males and two females, same data as holotype; one male, same data as allotype. Holotype, allotype and most of the paratypes in UMMZ; two male paratypes in the collection of C. P. Alexander, NMNH. The holotype and three male paratypes are mounted on microscope slides.

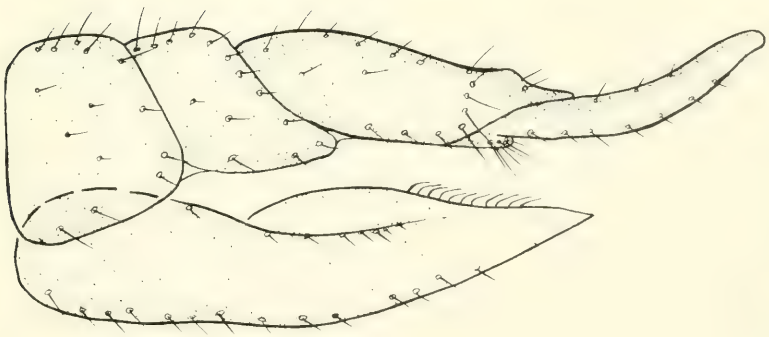
TAXONOMIC CHARACTERISTICS. Basic coloration brownish yellow. Male body length 8-8.5 mm, wing 8.5 mm. Female body length 8.5-9 mm, wing 9 mm. *Head* ashy gray, with one row of brown bristles around each eye. Rostrum brown, palpi dark brown. Antennae with dark brown scape, pedicel and flagellomeres brown. Verticils long, about 2.5 times length of their respective flagellomeres. *Thorax* brownish yellow, with gray pruinosity on all surfaces. Prescutum with grayish, poorly defined stripes. Pseudosutural foveae brown. Wings with brownish yellow tinge, costal fringe short, vein 2A without setae. Legs with coxae sparsely pruinose, trochanters, femora, and tibiae yellow, tarsomeres brown. *Abdomen* generally light brown; segment seven in male darker, forming dark subterminal ring. Male hypopygium (Fig. 41) yellowish brown. Dorsal dististyle evenly curved toward acicular apex, finely denticulate on outer curvature. Ventral dististyle with enlarged, rounded apex. Male genitalia (Fig. 42) with oval vesica. Lateral process reaching to about mid-length of basistyle, with apex directed slightly laterad. Anterior apodemes long and slender, separated at their bases. Lateral apodemes with lower part larger than upper

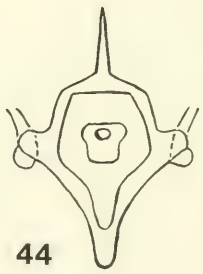
part. Ventral apodeme slender from both dorsal and lateral aspects. Aedeagus short, bent ventrad. Aedeagal process with broad, plate-like upper part, curved at sides and darker at posterior margin, connected posteriorly to median rod-like lower part hanging down behind aedeagus. Female genitalia (Fig. 43) of *germana* form. Cerci about same length as tenth tergum, evenly curved to slightly narrowed apex. Hypovalves reaching to about one-third length of cerci; eleven setae on inner dorsal edge of each hypovalve. In postero-ventral aspect of external reproductive structures (Fig. 44), ninth sternum fused with genital furca, sides of ninth sternum angularly bent.

COMPARATIVE NOTES. D. australis and *megaphallus* are similar to each other in having yellowish body color and a darkened subterminal ring on the abdomen in males. Males of these two species can be distinguished by the subterminal ring. In *D. australis* it is formed by the darkened seventh segment, while in *megaphallus* it is formed by darkening of both segments six and seven. Females of these two species can be separated by the form of the ninth sternum, which in the former has angularly bent sides and in the latter has rounded sides.

GEOGRAPHIC AND SEASONAL DISTRIBUTION. Collection records show that *D. australis* occurs from Indiana southward to central Florida, westward to Oklahoma (Map 1),







FIGURES 41-44. *Dicranoptycha (D.) australis.* 41, male hypopygium, dorsal aspect. 42, left lateral aspect with external skeleton removed. 43, female hypopygium, left lateral aspect. 44, postero-ventral aspect.

very closely approximating the range of *winnemana*. There is a four-month range of collection dates. Since the earliest date (15 April) was recorded from Florida and the latest date (26 August) was from Indiana, I believe that the difference in latitude accounts for this range and that *D. australis* has only one generation per year, as in the other nearctic species of the genus. The peaks of emergence differ locally; the collection records show May in Florida and August in Indiana.

Summary of distribution: Alabama - Baldwin Co., 14 May; Hale Co., 18 May. Florida - Alachua Co., 15 April, 10 May; Hamilton Co., 1 June; Marion Co., 29 May. Georgia - Bibb Co., 3 June; Burke Co., 30 June; Decatur Co., 8 June; Dooley Co., 1 June. Indiana - Jefferson Co., 31 July to 26 August. Missouri - Taney Co., 27 June. Oklahoma - Cleveland Co., 14 July; Pontotoc Co., 18 July. South Carolina - Abbeville Co., 27 June.

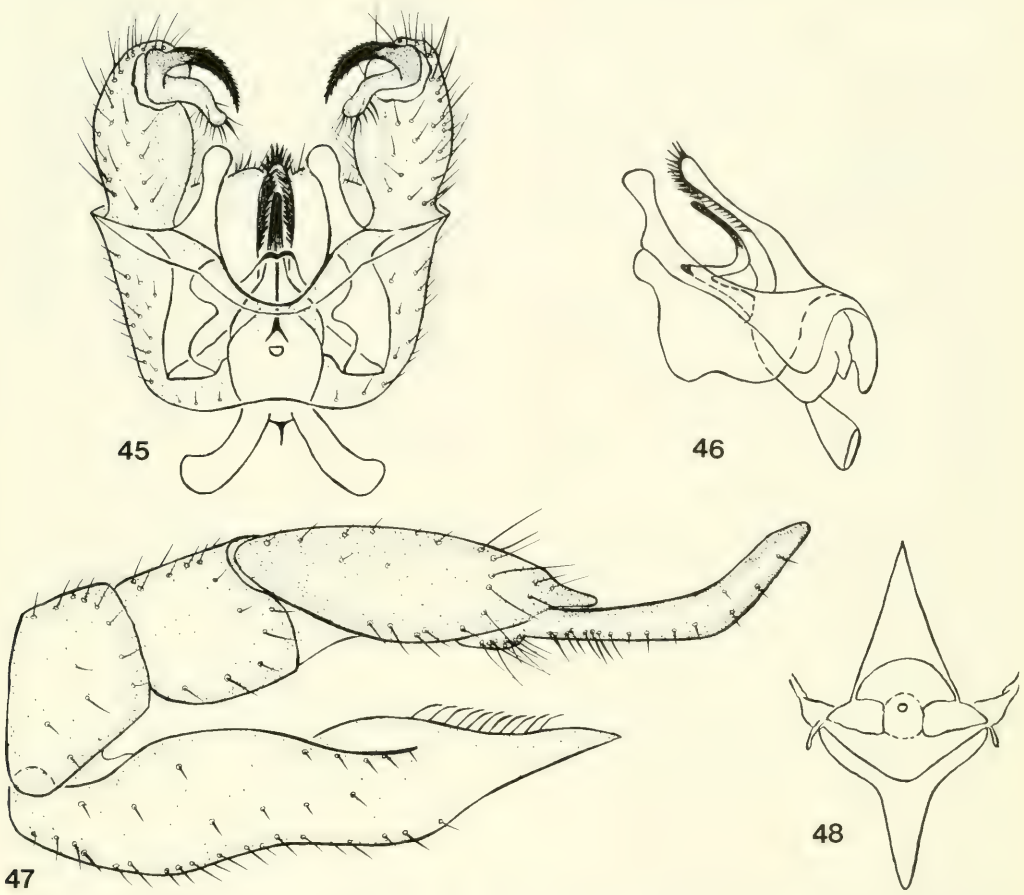
Dicranoptycha (Dicranoptycha) byersi, new species

TYPES. Holotype, male, Sunburst Forest Service Campground (10 miles southeast of Waynesville), Haywood County, North Carolina, 31 May 1978, G. W. Byers and C. W. Young. Allotype, same locality and date. Paratypes, 13 males and 3 females from the type locality, 31 May 1978, 1 male and 5 females from Morgan State Forest (4 miles north of Petros, 1850 feet) Morgan County, Tennessee, 1 June 1978. All types are in SEM. *Dicranoptycha byersi* is named in honor of Dr. George W. Byers, who discovered the habitat and helped collect the type series.

DESCRIPTION. Basic coloration dark brown. Male body length 8.5-9 mm, wing 10.5 mm. Female body length 9.5-11 mm, wing 12 mm. *Head* ashy gray, with one row of black bristles around each eye. Rostrum brown, pruinose; palpi blackish brown. Antennae with scape, pedicel and basal flagellomeres tawny, outer flagellomeres brown. Scape oblong, about twice as long as spherical pedicel. Flagellomeres oval, verticillate; dorsal verticils about twice as long as ventral ones, which just slightly exceed length of their respective segments. *Thorax* mostly dark brown, with gray pruinosity on pleurae. Mesonotum with light gold pruinosity, pseudosutural foveae polished black, longitudinal stripes on prescutum indistinct. Wings with ground color smoky yellow, a distinct brown seam along entire length of vein Cu. Veins testaceous, with setae on all longitudinal veins except 2A. Halteres pale throughout. Coxae tawny, bases of coxae pruinose. Trochanters yellow. Femora and tibiae yellow to testaceous with the brown tips, basitarsi testaceous, tarsomeres dark brown. *Abdomen* dark brown with light pollinosity. Male hypopygium (Fig. 45) brown. Dorsal dististyle evenly curved and narrowed toward apex, more abruptly curved at apex, both outer and inner curves denticulate. Ventral dististyle curved cephalad and with slightly enlarged apex. Male genitalia (Fig. 46) with vesica oval. Lateral process broadly expanded at tip. Anterior apodemes broad and separated from each other at their bases. Ventral apodeme small, keel-like. Aedeagus blade-like, curved upward from vesica with erect spines along entire edge. Aedeagal process complicated, with flat upper part, two lobed and darker at its posterior margin connected ventrally to upcurved, hook-like lower part situated medially above aedeagus. Female genitalia (Fig. 47) of *germana* form. Cerci slightly shorter than tenth segment, slightly broadened subapically, then tapered toward end. Hypovalves extending slightly beyond basal one-third of cerci; eleven setae on inner dorsal edge of each. Posteroventral aspect of external reproductive structures (Fig. 48) shows bases of ninth sternum extending into membranous area. Aperture of bursa copulatrix wide at level of membrane but narrowed anteriorly toward spermathecal ducts.

COMPARATIVE NOTES. *D. byersi* and *spinifera* are the only known species in which the aedeagus has spines that can be seen easily with a hand lens. In *D. byersi* the aedeagus curves upward and has spines all around the edge, while in *spinifera* the aedeagus is straight and bears spines only at the tip. In spite of the similarity of spiny aedeagi, these two species are not closely related, as indicated by the differences in all details of male genitalial structures (Figs. 45, 85). *D. byersi* is similar in its general appearance to *acanthophallus* but differs conspicuously in the structure of the male genitalia. The latter has a shorter, straight aedeagus (Fig. 37) and tiny spines on its inner surface that can be seen only with a compound microscope.

GEOGRAPHIC AND SEASONAL DISTRIBUTION. *D. byersi* is so far known only from two localities (Map 2). In both places, flies were



Figures 45-48. *Dicranoptycha (D.) byersi.* 45, male hypopygium, dorsal aspect. 46, left lateral aspect with external skeleton removed. 47, female hypopygium, left lateral aspect. 48, postero-ventral aspect.

MAP 2. Known distribution of *Dicranoptycha byersi* (triangles) and *D. minima* (circles).

collected with *D. acanthophallus* in hillside woods of tulip trees, maple, some oak and dogwood, where the shaded undergrowth included *Eupatorium,* jewelweed, poison ivy and bugbane. It seems likely that the range of *D. byersi* does not extend far west from these two localities, but it may occur in northern Georgia and elsewhere in the southern Appalachians. To judge from the collection dates and abundance of males at the time of collecting, *D. byersi* probably reaches peak abundance in the southern Appalachian region in late May and early June and can be described as a late spring species.

Dicranoptycha (Dicranoptycha) elsa Alexander

Dicranoptycha elsa Alexander, 1929, Bull. Brooklyn Entomol. Soc. 24: 28.

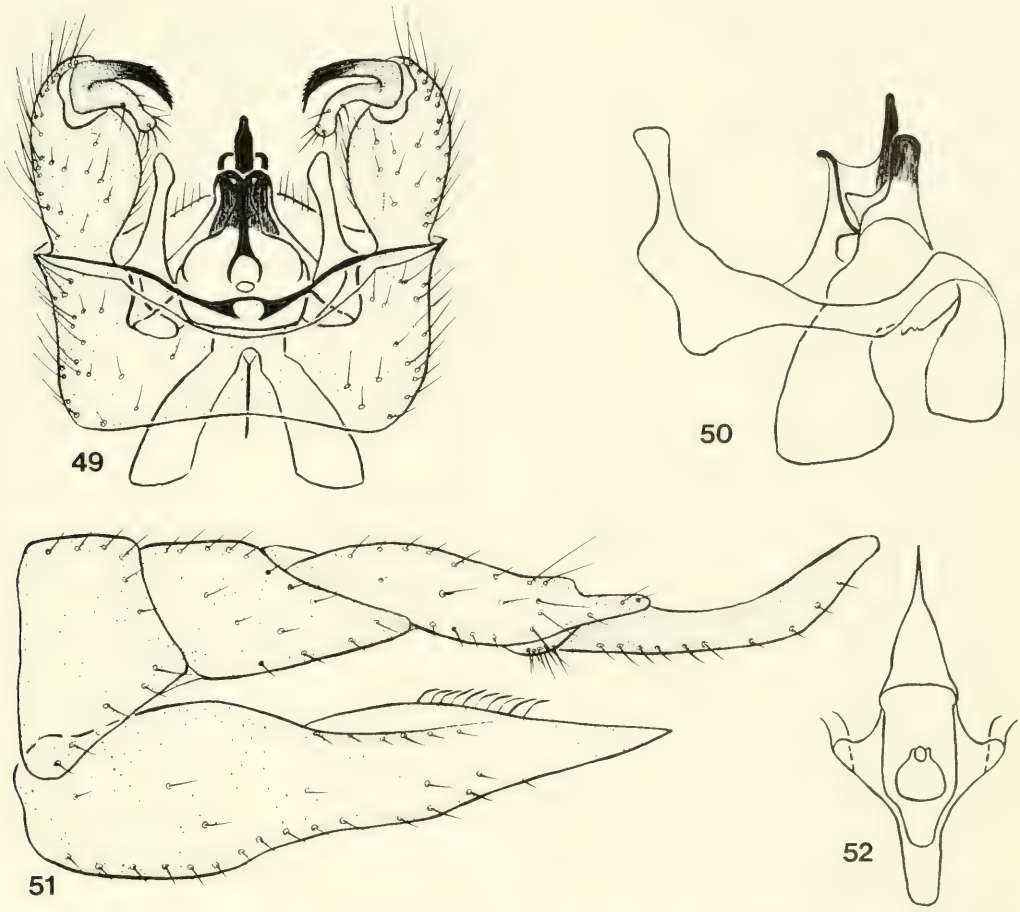
Types. Holotype, male, Tunesassa, Cattaraugus County, New York, 19 August 1926, C. P. Alexander. Allotype, same data as holotype. Holotype and allotype are in the collection of C. P. Alexander, NMNH. The holotype is mounted on a microscope slide.

Taxonomic Characteristics. Basic coloration ochraceous to brown. Male body length 9.5-10.5 mm, wing 10 mm. Female body length 11-12 mm, wing 11.5 mm. (The female body length disagrees with that given in the original description, 10 mm. I measured twenty flies from three localities.) *Head* bluish ashy gray with one row of black bristles around each eye. Rostrum yellowish brown, palpi dark brown. Antennae with scape brown, pedicel brownish yellow, flagellomeres brown. *Thorax* dark brown with dense gray pruinosity. Mesonotum dark gray, prescutum with a broad brown stripe, which is indistinctly divided longitudinally by a narrow gray line at its posterior end. Pseudosutural foveae polished black. Wings infumed with yellow to testaceous, strongly iridescent under light from certain angles; vein 2A without setae, costal fringe short. Legs yellow to testaceous, tarsomeres dark brown. *Abdomen* darker than thorax, with light gray pruinosity. In male, segments six to eight more blackened. Hypopygium (Fig. 49) brownish yellow. Dorsal dististyle narrowed beyond mid-length toward acute apex; apical half roughened and denticulate. Ventral dististyle broad at base and curved before expanded apex. Male genitalia (Fig. 50) with vesica rounded. Lateral process extending to about mid-length of basistyle, apex slightly expanded. Upper part of lateral apodeme broadly expanded. Anterior apodemes large, separated to base, widely divergent. Ventral apodeme keel-like, well developed. Aedeagus short, thick, concave dorsally with a notch on upper posterior end. Aedeagal process complicated, upper part a flattened plate, darkened at posterior margin, connected to hook-like lower part posteriorly, lower part extended above and beyond tip of aedeagus. Female genitalia (Fig. 51) of *germana* form. Cerci about same length as tenth tergum, curved upward near mid-length and slightly broadened subapically, tips rounded. Hypovalves reaching to about mid-length of cerci; ten setae on dorsal inner edge of each hypovalve. Postero-ventral aspect of external reproductive structures as in Fig. 52.

Comparative Notes. D. elsa is one of four dark brown species of the eastern species group. It can be easily recognized by lack of the dark brown seam along the Cu vein. The male of *D. elsa* is most likely to be confused with *acanthophallus*. Distinctions between these two species are included in the discussion of the latter. Alexander (1929) described the aedeagus as deeply split by an acute V-shaped notch. This was later illustrated in his Diptera of Connecticut (Alexander, 1942, Fig. 39D). Having examined the holotype and numerous other male specimens, I believe this described split is in the upper part of the aedeagal process as it appears on slide-mounted specimens.

Geographic and Seasonal Distribution. Collection records show that *D. elsa* occurs from New York westward to eastern Kansas, and southward along the Appalachian Mountains to northeastern Georgia (Map 3). The distribution map shows a wide gap between the Kansas and eastern records; since suitable habitats exist within this gap, I believe further collection will prove that this species is more widespread in the eastern United States than present records indicate. In eastern Kansas the adults emerge from late May to mid June. Collection dates from Georgia, Ohio, North Carolina and Tennessee show peak emergence in mid June, indicating D. elsa is an early summer species. However, the August record from New York indicates that the peak

MAP 3. Known distribution of *Dicranoptycha elsa*.



Figures 49-52. *Dicranoptycha (D.) elsa.* 49, male hypopygium, dorsal aspect. 50, left lateral aspect with external skeleton removed. 51, female hypopygium, left lateral aspect. 52, postero-ventral aspect.

of emergence might be later in the northern part of the range.

Summary of distribution: Georgia - Towns Co., 21-30 May; White Co., 21 May. Kansas - Cherokee Co., 24 June; Douglas Co., 19 May to 11 June. New York - Cattarangus Co., 19 August. North Carolina - Avery Co., 1 June; Buncombe Co., 30 May. Ohio - Athens Co., 28 May; Hocking Co., 7 June. Tennessee - Fentress Co., 2 June; Morgan Co., 1 June. Virginia - Botetourt Co., 19 June; Rockbridge Co., 4 June.

Dicranoptycha (Dicranoptycha) germana Osten Sacken

Dicranoptycha germana Osten Sacken, 1859, Proc. Acad. Nat. Sci. Philadelphia, 1859: 217.

Types. Osten Sacken described *Dicranoptycha germana* from eight male and nine female specimens collected near Trenton Falls, Oneida County, New York, in July 1858. Of these original 17, one male and three female syntypes are in MCZ. The female types are darker than the male. The remaining syntypes could not be found.

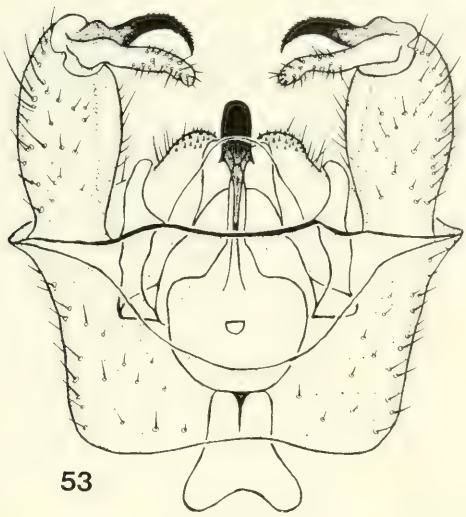
Taxonomic Characteristics. Basic coloration brownish yellow to reddish brown. Male body length 8-9.5 mm, wing 10-11 mm. Female body length 8.5-9.5 mm, wing 10-11.5 mm. *Head* cinereous, densely covered with long dark brown bristles. Rostrum brown, palpi blackish brown. Antennae with scape, pedicel tawny, flagellomeres brown. Verticils twice as long as their respective flagellomeres. *Thorax* varies from

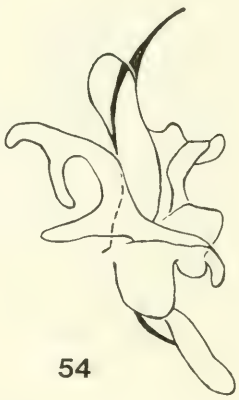
tawny to brown with gray pruinosity on pleura. Mesonotum with brownish gray tinge, without longitudinal stripes. Pseudosutural foveae reddish brown. Wings with strong reddish brown tinge, with golden yellow setae on all longitudinal veins, costal fringe long and conspicuous. Halteres brownish yellow throughout. Legs uniformly testaceous in light colored individuals, only tarsomeres brown; in dark color phase, legs uniformly brown except bases of femora brown. *Abdomen* with terga uniformly reddish brown, sterna varying from tawny to reddish brown. In male, seventh and eighth segments form dark brown subterminal ring, hypopygium brown, posterior end of ninth sternum (gonapophyses, Alexander 1942) covered with short dark spines. Male hypopygium (Fig. 53) with dorsal dististyle tapering evenly toward apex, outer surface and apical inner surface denticulate. Ventral dististyle slightly arcuate, covered with setae. Male genitalia (Fig. 54) with vesica oval. Lateral process short, extending to about one-third length of basistyle. Anterior apodemes fused at mid-line, forming bilobed structure with dorsal crest at base. Ventral apodeme vestigial. Aedeagus short, inconspicuous, with bilobed end. Aedeagal process with upper part pale, flat, rounded at posterior margin, connected medially below to darkly sclerotized, tongue-like lower part curved ventrad. Female genitalia (Fig. 55) with blade-like cerci, about same length as tenth segment. Cerci slightly broadened at mid-length and slightly rounded toward tips. About a dozen long setae around mid-length of tenth tergum. Hypovalves not reaching mid-length of cerci, eleven setae on inner dorsal margin of each hypovalve. Posteroventral aspect of external reproductive structures as in Fig. 56.

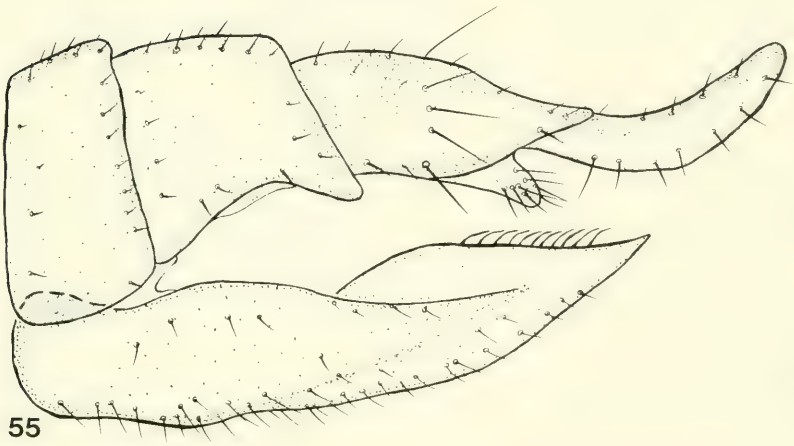
COMPARATIVE NOTES. This species shows striking variation in body color, from dark reddish brown individuals to light brownish yellow ones. The dark colored flies may be easily identified by their reddish brown wings and body. Specimens of the light color phase resemble *D. pallida,* but in that species the femora, tibiae and tarsomeres have dark tips, whereas these dark tips are absent in *D. germana. D. germana* also has a more hairy appearance than any other nearctic *Dicranoptycha.* Besides its conspicuous coloration, this species is distinct from the others in having setae on vein 2A and males with clusters of spines on the posterior end of the tenth sternum. Color variation in this species is independent of geographic distribution or ecological factors. Both color phases have been collected in the same habitats at various localities. The variation could be related to age, but more observations are needed to verify this hypothesis. Alexander (1942) described the costal fringe of *D. germana* as relatively short; he probably compared it with *sobrina* which has a longer costal fringe. Also in his figure (1942, Fig. 39E) the structure labelled as aedeagus is actually the tongue-like upper part of the aedeagal process. He also indicated the tips of the lateral process as acute in both his description and figure. I have examined many individuals and find them quite blunt.

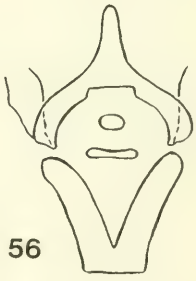
GEOGRAPHIC AND SEASONAL DISTRIBUTION. *D. germana* is known from Quebec westward to northern Minnesota and southward to South Carolina (Map 4). This is, so far as known, the only species of this genus that inhabits the Canadian life-zone. All the other species are characteristic of the Transitional and Austral life-zones. A series collected by J. Speed Rogers at Mountain Lake, Virginia, shows that this species emerges in late May and continues on the wing through mid-August, with a peak in mid-June. In the northern part of its range, *D. germana* emerges in June and disappears in October, with the peak in July.

Summary of distribution: Maryland - Garrett Co., 4 July; Montgomery Co., 5 July; Prince Georges Co., 29 May to 14 June. Michigan - Antrim Co., 2 July; Cheboygan Co., 26 July; Clare Co., 3 July; Gogebic Co., 24 July to 3 August; Lake Co., 22-26 June; Marquette Co., 13, 14 July; Osceola Co., 20 June; Washtenaw Co., 5 July. Minnesota - Clearwater Co., 11 July. New Hampshire - Grafton Co., 6 July. New York - Erie Co., 7 September; Essex Co., 5 August; Herkimer Co., 19 July; Oneida Co., 15 July; Tompkins Co., 20 July. North Carolina - Avery Co., 1 June. Ohio - Hocking Co., 4 October. Pennsylvania - Luzerne Co., 6 June. Quebec - Brome Co., 12 July, 2 September; Kamouraska Co., 5 July, 7 October. South Carolina - Spartanburg Co., 1 June. Virginia - Bath Co., 1 July; Fairfax Co., 6









FIGURES 53-56. *Dicranoptycha (D.) germana.* 53, male hypopygium, dorsal aspect. 54, left lateral aspect with external skeleton removed. 55, female hypopygium, left lateral aspect. 56, postero-ventral aspect.

June; Giles Co., 25 May to 15 August; Page Co., 15 July. West Virginia - Randolph Co., 5 July; Tucker Co., 3 July.

Dicranoptycha (Dicranoptycha) megaphallus Alexander

Dicranoptycha megaphallus Alexander, 1926, Psyche, 33: 57.

TYPE. Holotype, male, Allardt, Fentress County, Tennessee, at light, altitude 1650 feet, 10 June 1924, J. S. Rogers. The holotype is in UMMZ. The hypopygium is mounted on a microscope slide, and the remainder is pinned. The head and thorax of the type are greasy and the color has turned dark.

TAXONOMIC CHARACTERISTICS. Basic coloration yellow. Male body length 9-9.5 mm, wing 9 mm. Female body length 9.5-10 mm, wing 10 mm. *Head* yellow, with one row of yellowish bristles around each eye. Rostrum and palpi brownish yellow. Antennae with scape, pedicel and basal four flagellomeres yellow, outer flagellomeres brownish yellow. Verticils about twice length of their respective flagellomeres. *Thorax* yellow with brownish yellow pruinosity on all surfaces. Prescutum with darker color along mid-line forming one brownish longitudinal

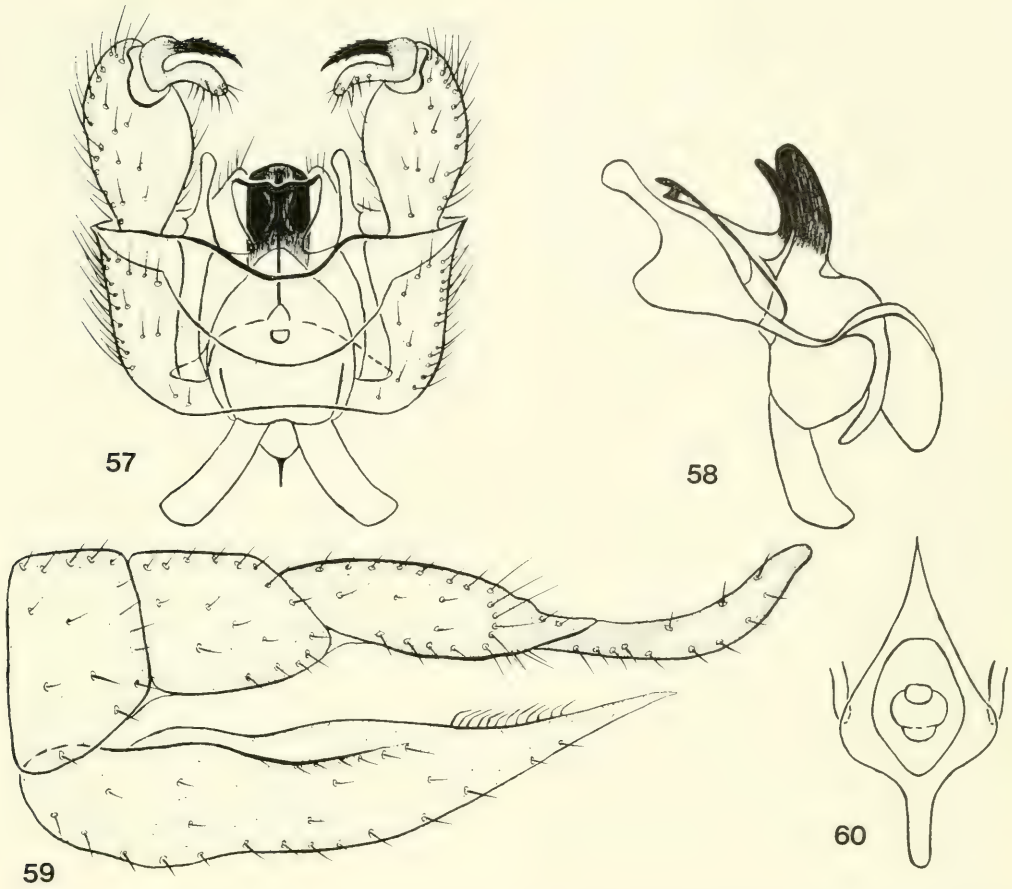
MAP 4. Known distribution of *Dicranoptycha germana.*

stripe. Pseudosutural foveae brown. Wings with yellow tinge, strongly iridescent, costal fringe short, vein 2A without setae. Legs yellow; outer tarsomeres brownish. *Abdomen* brownish yellow. Male with segments six and seven dark brown, forming broad subterminal ring. Male hypopygium (Fig. 57) yellow. Dorsal dististyle slender beyond slightly enlarged basal portion, evenly curved toward blackened, acicular apex, with denticulation on both outer and inner surfaces. Ventral dististyle slightly sclerotized, constricted near base. Male genitalia (Fig. 58) with large oval vesica. Lateral process reaching to about mid-length of basistyle. Lateral apodeme with both upper and lower parts expanded. Anterior apodemes conspicuous, elongate, and widely divergent from base. Ventral apodeme keel-like, well developed. Aedeagus conspicuous, large, dorso-ventrally flattened, with broadly rounded apex. Aedeagal process of *sobrina* form, with flattened, plate-like upper part, darker at posterior margin, connected anteriorly to hook-like lower part lying above aedeagus and narrowly connected to its sides. Female genitalia (Fig. 59) of *germana* form. Cerci about same length as tenth segment, evenly curved upward, with narrowly rounded apices. Hypovalves reaching to about mid-length of cerci; twelve setae on inner dorsal edge of each hypovalve. Postero- ventral aspect of external reproductive structure as in Fig. 60.

COMPARATIVE NOTES. D. megaphallus is closely related to *sobrina* and *tennessa* on the basis of male genitalial characteristics. Dr. J. S. Rogers recorded in his study notes that "*sobrina, megaphallus,* and probably *tennessa* are very close, probably geographic, ecological or other variants of one species." However, the distinct coloration of each species will at once separate them. The male genitalia also provide reliable specific characters. Regardless of the specific name of *D. megaphallus, sobrina* has the largest aedeagus, then *tennessa* and *megaphallus.* There also are differences in the attachment of the lower part of the aedeagal process to the aedeagus. In *D. sobrina* and *tennessa,* the junction of these two structures is at the base of aedeagus, while in *megaphallus* it is about one-third the length of the aedeagus from the base. Furthermore, the sympatric occurrence of these three forms supports the view that they are full species.

GEOGRAPHIC AND SEASONAL DISTRIBUTION. D. megaphallus ranges from western Virginia southward to Florida and westward to the Ozark Mountains and eastern Kansas (Map 5). Although the species has a generally southern distribution, it probably ranges farther north than present collection records indicate. There is one male reported from Ohio (Foote, 1956), but since I have not been able to verify the identification, it is not shown on the map. In northern Florida, Rogers (1933) found that *D. megaphallus* frequents the herb and shrub strata of high hammocks, upland woods, and clay hill woods. The flight period indicated in that study was 11 to 27 April in the years 1933 through 1936. In eastern Kansas this is the first species of the genus to emerge and has a flight period from late May to mid June. Collection dates from Illinois and Missouri also show dates around mid June. Accordingly, *D. megaphallus* appears to be a spring to early summer species, depending on latitude.

Summary of distribution: Alabama - Hale Co., 3 May. Arkansas - Marion Co., 15-16 May; Washington Co., 27 May. Florida - Jackson Co., 12-21 April; Jefferson Co., 18 April; Leon Co., 16-23 April; Liberty Co., 11 April. Georgia - Fulton Co., 21 May. Illinois - Randolph Co., 2



FIGURES 57-60. *Dicranoptycha (D.) megaphallus*. 57, male hypopygium, doral aspect. 58, left lateral aspect with external skeleton removed. 59, female hypopygium, left lateral aspect. 60, postero-ventral aspect.

June. Kansas - Cherokee Co., 7-13 June; Douglas Co., 21 May to 17 June; Franklin Co., 27 May; Johnson Co., 7 June; Labette Co., 2 June; Morris Co., 14 June; Pottawatomie Co., 14 June; Riley Co., 7 June. Kentucky - Christian Co., 3 June. Louisiana - Caddo Parish, 8 May. Missouri - Barry Co., 13-18 June; Camden Co., 1 June; Carter Co., 6 June; Laclede Co., 13 June; Taney Co., 10 June. Oklahoma - Adair Co., 15-17 June; Delaware Co., 19 June; Mayes Co., 18 June; Rogers Co., 6-19 June. Tennessee - Fentress Co., 10 June; Greene Co., 18 June. Virginia - Giles Co., 4 June.

MAP 5. Known distribution of *Dicranoptycha megaphallus*.

Dicranoptycha (Dicranoptycha) minima Alexander

Dicranoptycha minima Alexander, 1919, Entomol. News, 30: 21.

Types. Holotype, male, Lawrence, Douglas County, Kansas, altitude 900 feet, 16 July 1918, C. P. Alexander. Allotype, same data as holotype. Paratypes, 50 male and female, 11 September 1917. Twenty-two male and eight females paratypes are together with the holotype and allotype in the collection of C. P. Alexander, NMNH. Six male and two female paratypes are in UMMZ. Two male paratypes are in SEM. I have not been able to locate the other 10 paratypes. The holotype and three male paratypes are mounted on microscope slides.

Taxonomic Characteristics. General coloration brownish yellow. Male body length 6 mm, wing 6-6.5 mm. Female body length 6.5 mm, wing 6.5 mm. *Head* brown with golden pruinosity, one row of dark bristles around each eye. Rostrum brown, palpi dark brown. Antennae brownish black. Verticils long, about twice length of their respective flagellomeres. *Thorax* brownish yellow. Prescutum light borwn without longitudinal stripes. Pseudosutural foveae brown, pleura with light gray pruinosity. One distinct black spot at low end of pleural suture on mesothorax. Wings with strong brownish tinge, costal fringe short, inconspicuous. Legs with coxae yellow, heavily pruinose, trochanters yellow, femora and tibiae yellow with distinctly dark brown tips, tarsomeres dark brown. *Abdomen* yellowish brown without darker subterminal ring. Male hypopygium (Fig. 61) yellow. Dorsal dististyle smooth, broad at base and narrowed at about mid-length toward pointed tip. Ventral dististyle short, broad, setiferous. Male genitalia (FIg. 62) with vesica longer than wide; lateral process, short extending to about one-third length of basistyle. Both upper and lowers parts of lateral apodeme narrow. Anterior apodeme about same width as vesica at its base, broader at anterior margin, with shallow notch. Ventral apodeme small, keel-like. Aedeagus small, bilobed at posterior margin, with hook-like structure in front of each lobe; all these four projections bend ventrad. Aedeagal process absent. Female genitalia (Fig. 63) of *germana* form. Cerci about same length as tenth tergum, narrow at base, slightly widened just beyond mid-length, narrowed to upcurved tip. Hypovalve reaching to about mid-length of cerci; twelve setae on inner dorsal edge of each hypovalve. Postero-ventral aspect of external reproductive structures as in Fig. 64.

Comparative Notes. D. minima is the smallest species in the eastern species group. The only other species that it might be confused with is *D. septemtrionis,* but they may be distinguished by the dark brown tips of the femora and tibiae, and the smooth rather than denticulate dorsal dististyles of *D. minima.*

Geographic and Seasonal Distribution. D. minima is rarely seen in museum collections. I have seen specimens only from Kansas and Oklahoma and cannot verify the record for Illinois (Alexander, 1942). *D. minima* probably has a central plains distribution (Map 2). All but one of the collection dates are in September. The date for the holotype and allotype is in July. It is possible that Alexander described this species from laboratory-reared adults, which he mentioned emerged over a month earlier than the first individual taken in the field (Alexander, 1919b:68). *D. minima* is a late-summer to early-fall species.

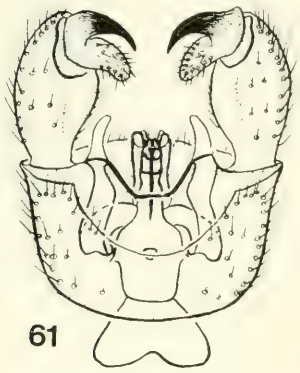
Summary of distribution: Kansas - Douglas Co., 16 July and 11 September; Jefferson Co., 15 September. Oklahoma - Kiowa Co., 3 September; Latimer Co., 26 September; Love Co., 7 September; Okfuskee Co., 4 September; Pontotoc Co., 6 September.

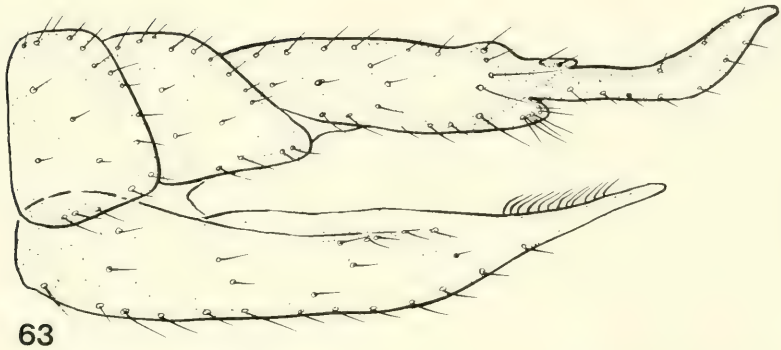
Dicranoptycha (Dicranoptycha) nigripes Osten Sacken

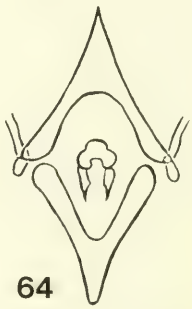
Dicranoptycha nigripes Osten Sacken, 1859, Proc. Acad. Nat. Sci. Philadelphia, 1859: 218.

Type. The original description was based on a male collected at Dalton, Whitfield County, Georgia, in 1859, by Osten Sacken; no more detailed data were mentioned. This type specimen is MCZ. It has intact body and wings but is without legs; one broken leg is attached to the determination label.

Taxonomic Characteristics. General coloration reddish yellow. Male body length about 10.5 mm, wing 9.5 mm. Female body length about 10.5 mm, wing 9.5 mm. *Head* ochraceous, with one row of dark brown bristles around each eye. Rostrum brown, palpi dark brown. Antennae black in male; in female, basal two segments yellow, flagellomeres brown. Verticils short, about same length as respective flagellomeres. *Thorax* reddish yellow, with strong pruinosity on all surfaces. Prescutum



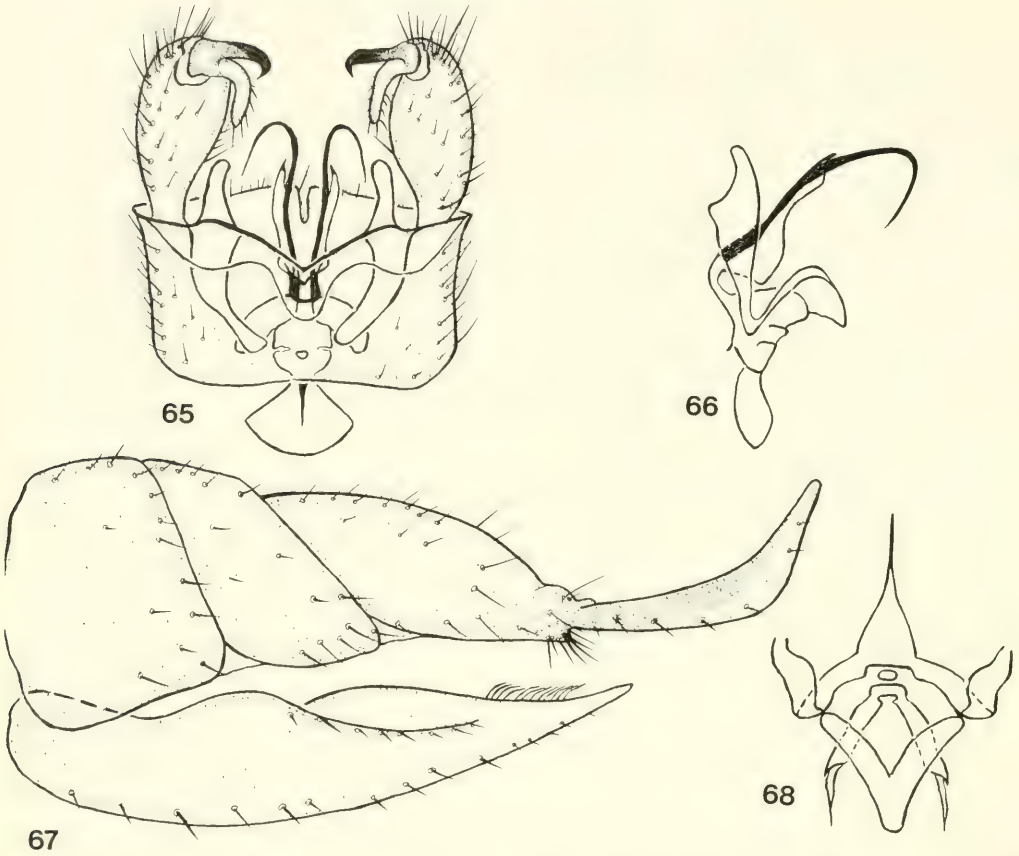




FIGURES 61-64. *Dicranoptycha (D.) minima.* 61, male hypopygium, dorsal aspect. 62, left lateral aspect with external skeleton removed. 63, female hypopygium, left lateral aspect. 64, postero-ventral aspect.

with one obscure median longitudinal stripe. Pseudosutural foveae reddish brown. Wings ferruginous, darker along anterior border, without setae on 2A, costal fringe short. Legs with coxae slightly pruinose, remainder of leg tawny, tips of femora and tibiae dark brown, tarsomeres dark brown. *Abdomen* brownish yellow, sterna three to seven with transverse blackened band near mid-length. In male, segment eight with blackened subterminal ring. Male hypopygium (Fig. 65) yellow, with ninth tergum deeply notched, margin of lobes with long conspicuous dark setae (omitted in figure). Dorsal dististyle abruptly narrowed and arcuate just before acute tip, outer curve glabrous. Ventral dististyle distinctly longer than dorsal one, strongly arcuate before mid-length, narrowed toward blunt tip. Male genitalia (Fig. 66) with small vesica. Lateral process broad at base and narrowed toward evenly rounded tip on both dorsal and lateral aspects. Lateral apodeme narrowed at middle, both upper and lower parts widened. Anterior apodeme single, without evidence of fusion of two apodemes, fan-like, narrow at base and widely expanded anteriorly. Ventral apodeme keel-like, well developed, about same size as anterior apodeme. Aedeagus short, inconspicuous. Aedeagal process (male forceps, Osten Sacken 1869) with two long, slender, dark structures branching out from base of aedeagus and bent ventrad, each branch with paler, thicker, darkly tipped secondary branch at about mid-length. Female genitalia (Fig. 67) of *germana* form. Cerci about as long as tenth segment, broadened beyond mid-length, tapered toward acute, upwardly curved tips. Hypovalves reaching slightly beyond base of cerci; twelve setae on inner dorsal edge of each hypovalve. Postero-ventral aspect of external reproductive structures (Fig. 68) shows inverted V-shaped receptacle for aedeagal process visible in membranous area below the aperture of bursa copulatrix.

COMPARATIVE NOTES. In general appearance, *D. nigripes* resembles *sobrina* and *tigrina,* particularly in having banded abdominal sterna. The close similarity of



FIGURES 65-68. *Dicranoptycha (D.) nigripes.* 65, male hypopygium, dorsal aspect. 66, left lateral aspect with external skeleton removed. 67, female hypopygium, left lateral aspect. 68, postero-ventral aspect.

color is discussed under *D. sobrina.* In hypopygial structure of the male, *D. nigripes* most closely resembles *tigrina,* particularly in having a branching aedegal process. It differs from the latter species at first sight by its larger size and more reddish coloration. Close examination of the male genitalia confirms this separation. In *D. nigripes* the secondary branch arises from about mid-length of the aedeagal process, while in *D. tigrina* it arises close to the tip.

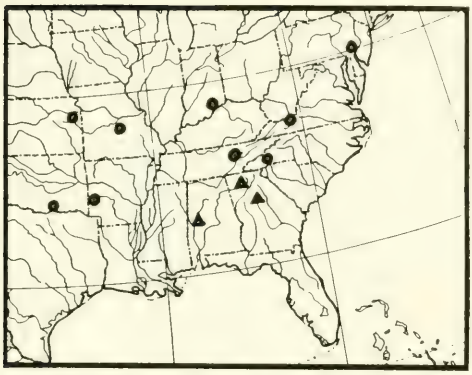
GEOGRAPHIC AND SEASONAL DISTRIBUTION. D. nigripes is so far known from only three localities, including the type locality in northwestern Georgia; Rogers' collection added two more records in western Alabama and central Georgia (Map 6). Absence of *D. nigripes* from the more northern Appalachians is possibly due to the fact that suitable habitats are occupied by the most closely related species, *D. tigrina.* Collection dates show that *D. nigripes* is probably a late-summer species.

Summary of distribution: Alabama - Hale Co., 18 July. Georgia - DeKalb Co., 16-25 August; Whitfield Co. (date unknown).

Dicranoptycha (Dicranoptycha) pallida Alexander

Dicranoptycha pallida Alexander, 1926, Psyche, 33: 58-59.

TYPES. Holotype, male, Lawrence (North Hollow, on the campus of the University of Kansas), Douglas County, Kansas, 1 August 1918,



MAP 6. Known distribution of *Dicranoptycha nigripes* (triangles) and *D. tigrina* (circles).

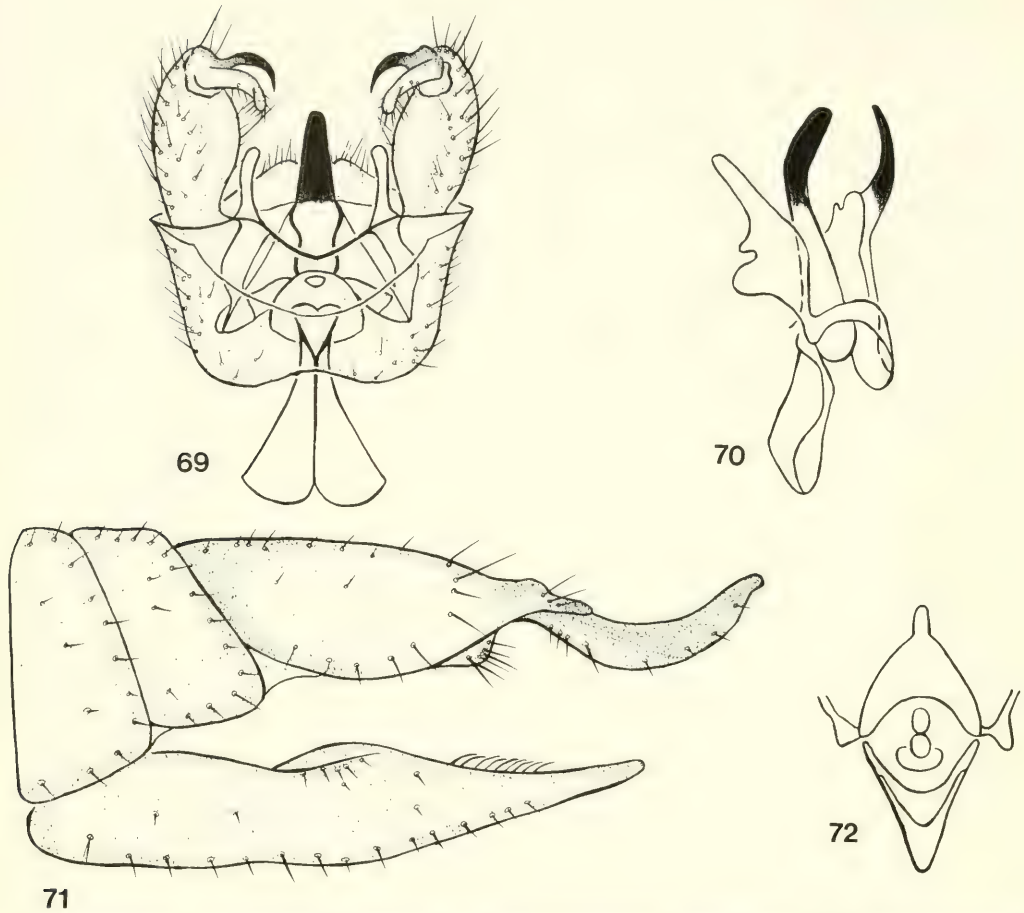
C. P. Alexander. Allotype, same locality and collector, 16 July 1918. Paratypes, four males and six females from the type locality, dated between 16 July and 1 August 1918. Holotype, allotype and most of the paratypes are in the collection of C. P. Alexander, NMNH. Two male and one female paratypes are in the UMMZ. The holotype and two male paratypes are mounted on microscope slides.

Taxonomic Characteristics. Basic coloration tawny. Male body length 7.5 mm, wing 8.5 mm. Female body length 9 mm, wing 9.5 mm. *Head* brownish yellow, with two rows of brown bristles around each eye. Rostrum brownish yellow, palpi brown. Antennae with scape, pedicel and basal four flagellomeres obscure yellow, outer flagellomeres infuscated. Verticils about twice as long as their respective flagellomeres. *Thorax* brownish yellow, with light gray pruinosity on pleura. Prescutum shiny brownish yellow, without longitudinal stripes. Pseudosutural foveae indistinct. Wings with strong brownish yellow tinge, with setae on all longitudinal veins except 2A; costal fringe short. Legs with coxae slightly pruinose, tronchanters obscure yellow, femora, tibiae and basal four tarsomeres yellow with darkened tips, apical tarsomeres brown. *Abdomen* with brownish yellow terga and pale yellow, slightly pruinose sterna. In male, segment seven conspicuously dark brown, eighth segment and hypopygium light yellow. Hypopygium (Fig. 69) with dorsal dististyle glabrous, evenly curved and narrowed toward apex. Ventral dististyle long, curved cephalad, narrowed toward blunt apex. Male genitalia (Fig. 69) with vesica rounded posteriorly. Lateral process extending to about midlength of basistyle. Lateral apodemes narrowed in lower part, upper part expanded. Anterior apodemes fused nearly their full length, about two and one-half times length of vesica, narrow at base, and separated by notch anterior margin. Ventral apodeme small, keel-like. Aedeagal process rod-like, dark in color and bent ventrad above dark, slender, tapering, upcurved aedeagus. Female genitalia (Fig. 71) of *germana* form. Cerci shorter than tenth segment, broadened near one-third length from base, then narrowed toward tips. Hypovalves reaching to about midlength of cerci; nine setae on inner dorsal edge of each hypovalve. Postero-ventral aspect of external reproductive structures (Fig. 72) with receptacle for aedeagal process beneath aperture of bursa copulatrix and receptacle for aedeagus above it.

Comparative Notes. Both sexes of *D. pallida* can be identified in the field by the conspicuously darkened tips of the femora, tibiae and tarsomeres. This character separates this species from the otherwise similar *D. winnemana.* Male specimens are readily distinguishable by their unique aedeagus and aedeagal process. Together, these structures form a pincers configuration in lateral aspect. Alexander (1926) mentioned that he had confused *D. winnemana* with this species in the following papers: 1919a,b; 1920a. The aedeagal process (gonapophysis, Alexander 1926) and aedeagus in Alexander's original figure of this species appear to be side by side in a horizontal plane rather than the former above the latter, as they occur anatomically. This effect is probably due to the fact that the specimen was slide-mounted.

Geographic and Seasonal Distribution. *D. pallida* has been found in northern Illinois, Ohio, southern Indiana and eastern Kansas (Map 7). It was not found in any of the collections of Rogers or Byers from more eastern or southeastern states. Collection dates show that *D. pallida* is a midsummer species. In eastern Kansas *D. pallida* has a flight period from late June to mid July, with the peak of emergence in early July.

Summary of distribution: Illinois - Winnebago Co., 16 July. Indiana -Jefferson Co., 27 July to 1 August. Kansas - Douglas Co., 24 June to 16 July; Harvey Co., 2 July; Jewell Co., 22 July; Montgomery Co., 29 June; Nemaha Co., 5 July. Ohio - Delaware Co., 4 September.



FIGURES 69-72. *Dicranoptycha (D.) pallida.* 69, male hypopygium, dorsal aspect. 70, left lateral aspect with external skeleton removed. 71, female hypopygium, left lateral aspect. 72, postero-ventral aspect.

MAP 7. Known distribution of *Dicranoptycha pallida* (triangles) and *D. spinifera* (circles).

Dicranoptycha (Dicranoptycha) septemtrionis Alexander

Dicranoptycha septemtrionis Alexander, 1926, Psyche, 33: 56.

Dicranoptycha microphallus Alexander, 1947, Entomol. News. 57: 249 (new synonymy).

TYPES. Holotype, male, Greenfield Mountain, Franklin Co., Massachusetts, 6 September 1925, G. C. Crampton. Two male and one female paratopotypes, 23 August to 6 September 1911, M. C. Van Duzee. Holotype and male paratopotypes are mounted on microscope slides. All types are in the collection of C. P. Alexander, NMNH. *Dicranoptycha microphallus* was described from a single specimen from Blood Mountain, Georgia, P. W. Fattig, 11

September 1945. The genitalia of the type are mounted on a microscope slide, the rest pinned. The type is in C. P. Alexander Collection, NMNH.

TAXONOMIC CHARACTERISTICS. Basic coloration brownish gray. Male body length 6.5-7.5 mm, wing about 8.5 mm. Female body length 8.5-9 mm, wing 8.5-9 mm. *Head* yellowish gray with one row of dark bristles around each eye. Rostrum brown, palpi black. Antennae with scape, pedicel yellow, flagellomeres dark brown. Verticils long, about two and a half times length of their respective flagellomeres. *Thorax* with brown nota and pale yellow pleura. Pronotum and prescutum dark brown, with sparsely gray pruinosity, without longitudinal stripes. Pseudosutural foveae dark brown. Wings with faint brownish tinge, strongly iridescent under light at certain angles, costal fringe short in both sexes. Halteres brownish yellow. Legs with coxae and trochanters yellow, femora and tibiae light brown, tarsomeres brown. *Abdomen* with brown terga and brownish yellow sterna. In male, segments seven and eight form dark brown subterminal ring. Male hypopygium (Fig. 73) brownish yellow. Dorsal dististyle slender, apical half blackened and strongly denticulate on all surfaces. Ventral dististyle gradually narrowed to blunt tip. Male genitalia (Fig. 74) with vesica rounded. Lateral process slender, gradually tapered toward narrowly rounded, slightly turned upward and inward apex. Lateral apodeme broad in upper part. Anterior apodemes joined medially for most of their length, narrow basally and slightly bilobate, expanded and curved outward anteriorly. Ventral apodeme small, poorly defined. Aedeagus small, with small upcurved hook at posterior end. Aedeagal process with small, flat, plate-like upper part turned dorsad, and flattened, darkly sclerotized lower part, curved downward above aedeagus. Female genitalia (Fig. 75) of *germana* form. Cerci about same length as tenth segment, slender, curved upward to rounded tip. Hypovalves extending slightly beyond base of cerci, twelve setae on inner dorsal edge of each hypovalve. Posteroventral aspect of external reproductive structures as in Fig. 76.

COMPARATIVE NOTES. D. septemtrionis most closely resembles *tennessa* in body coloration, but the small, inconspicuous aedeagus will readily separate males from *tennessa,* in which the aedeagus is large and massive. I have examined the type of *D. microphallus* which Alexander described from one male specimen. The genitalia were mounted at such an angle that the aedeagus was moved to one side and rotated so as to appear beside the aedeagal process with its side up. This might have led Alexander to regard *D. microphallus* as nearest to *septemtrionis* but with a slender aedeagus. Having compared several *D. septemtrionis* with the type of *microphallus,* I regard *microphallus* as a synonym of *septemtrionis.*

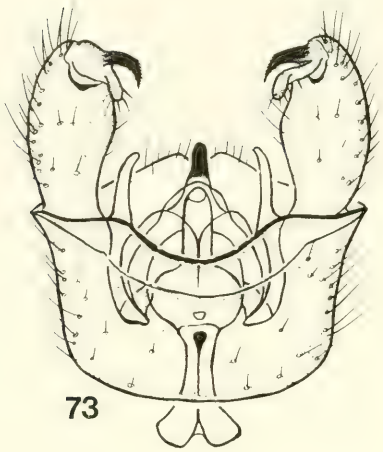
GEOGRAPHIC AND SEASONAL DISTRIBUTION. The range of *D. septemtrionis* is from Massachusetts, New York, southern Michigan westward to eastern Kansas and southwestward to North Carolina and Georgia (Map 8). *D. septemtrionis* is the most common fall species of the genus in the eastern group. In eastern Kansas it can be found from late July to early September, with the peak of emergence in mid-August.

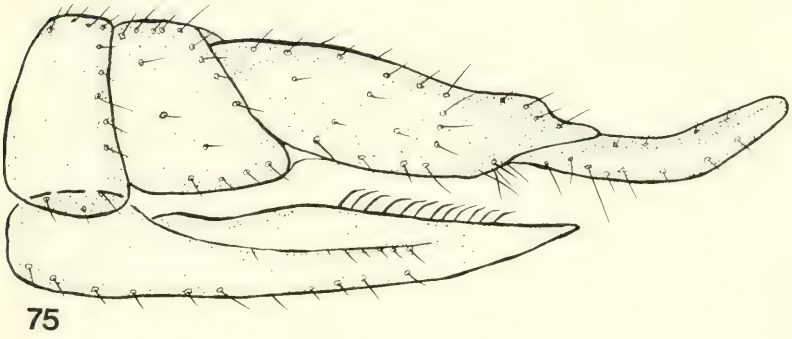
Summary of distribution: Georgia - Blood Mountain, 11 September. Indiana - Jefferson Co., 26 August. Kansas - Douglas Co., 16 July to 7 September. Kentucky - Grant Co., 6 August. Maryland - Prince Georges Co., 1 September; Plummers Island, 21 July. Massachusetts - Franklin Co., 23 August to 6 September. Michigan - Jackson Co., 9 August; Livingston Co., 9-28 August; Washtenaw Co., 13 August. New York - Niagara Co., 4 September. North Carolina - Avery Co., 4 September; Haywood Co., 4 September; Jackson Co., 29 August; Macon Co., 24 August to 4 September; Transylvania Co., 31 August; Yancey Co., 23 August. Ohio - Delaware Co., 4 September. Tennessee - Fentrees Co., 27 August. Virginia - Arlington, 20 August; Giles Co., 25 August to 5 September.

Dicranoptycha (Dicranoptycha) sobrina Osten Sacken

Dicranoptycha sobrina Osten Sacken, 1859, Proc. Acad. Nat. Sci. Philadelphia, 1850: 218.
Dicranoptycha sororcula Osten Sacken, 1859, Proc. Acad. Nat. Sci. Philadelphis, 1859: 218.
Dicranoptycha rogersi Alexander, 1927, Jour. N. Y. Entomol. Soc. 35: 55 (new synonymy).

TYPES. Osten Sacken originally described the species from seven males and five females col-





FIGURES 73-76. *Dicranoptycha (D.) septemtrionis*. 73, male hypopygium, dorsal aspect. 74, left lateral aspect with external skeleton removed. 75, female hypopygium, left lateral aspect. 76, postero-ventral aspect.

MAP 8. Known distribution of *Dicranoptycha septemtrionis*.

lected near Washington, D. C., in June 1859. Of these original twelve syntypes, one male and two females are in MCZ. The rest could not be found. *Dicranoptycha sororcula* was described from one male and one female from Dalton, Whitfield County, Georgia, July 1859. Osten Sacken placed this name in the synonymy of *D. sobrina* in 1869. I have been unable to locate the original specimens of *D. sororcula*. *Dicranoptycha rogersi* was described from seven specimens collected by J. S. Rogers in Marion County, Florida, on 13 April 1926. These specimens are in UMMZ.

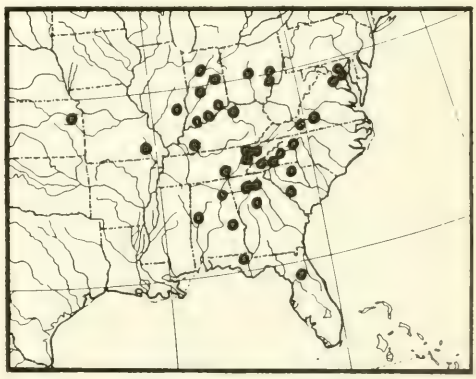
TAXONOMIC CHARACTERISTICS. Basic coloration grayish brown. Male body length 10-12 mm, wing 8-9 mm. Female body length 10-13 mm, wing 9-11 mm. *Head* gray, with single row of dark bristles around each eye. Rostrum and

palpi brown. Antennal flagellum brown, scape and pedicel paler. Verticils about three times as long as their respective flagellomeres. *Thorax* gray with yellowish brown pruinosity on all surfaces. Prescutum without longitudinal stripes. Pseudosutural foveae brown. Wings with pale cinereous tinge, costal margin darker; costal fringe dense and conspicuous, male with longer costal fringe than female. Halteres pale throughout. Legs mostly brownish yellow, fore femora dark brown, except basal one-fourth pale, remaining femora with brown tips. Tarsomeres dark brown except basal part of basitarsus paler. *Abdomen* with terga uniformly grayish brown; venter bicolorous, each sternum with anterior brown band and posterior yellow band. In male, segments six to eight blackened, forming darker, broad subterminal ring. Male hypopygium (Fig. 77) yellow. Dorsal dististyle broad at base, slightly curved, rather abruptly bent and acicular at apex, outer curvature denticulate, inner glabrous. Ventral dististyle shorter than dorsal one, evenly and slightly curved, apex blunt but not knobbed. Male genitalia (Fig. 78) with vesica oval. Lateral process extending to about two-thirds length of basistyle. Anterior apodemes broad, separated to base, widely divergent. Keel-like ventral apodeme well developed. Aedeagus large, darkened, curved upward from vesica, dorso-ventrally flattened with a dorsal, longitudinal depression, apex broadly rounded. Aedeagal process complicated, with upper, flattened, plate-like structure, darker at its posterior, broadly notched margin connected anteriorly to lower, upcurved, hook-like part situated medially in depression of aedeagus and attached to the base of aedeagus. Female genitalia (Fig. 79) of *germana* form. Cerci about same length as tenth segment, slightly narrowed and curved upward in apical half. Hypovalves extending to about midlength of cerci; eleven setae on inner dorsal edge of each hypovalve. Postero-ventral aspect of external reproductive structures as in Fig. 80, ninth sternum and genital furca fused together forming a ring-like structure.

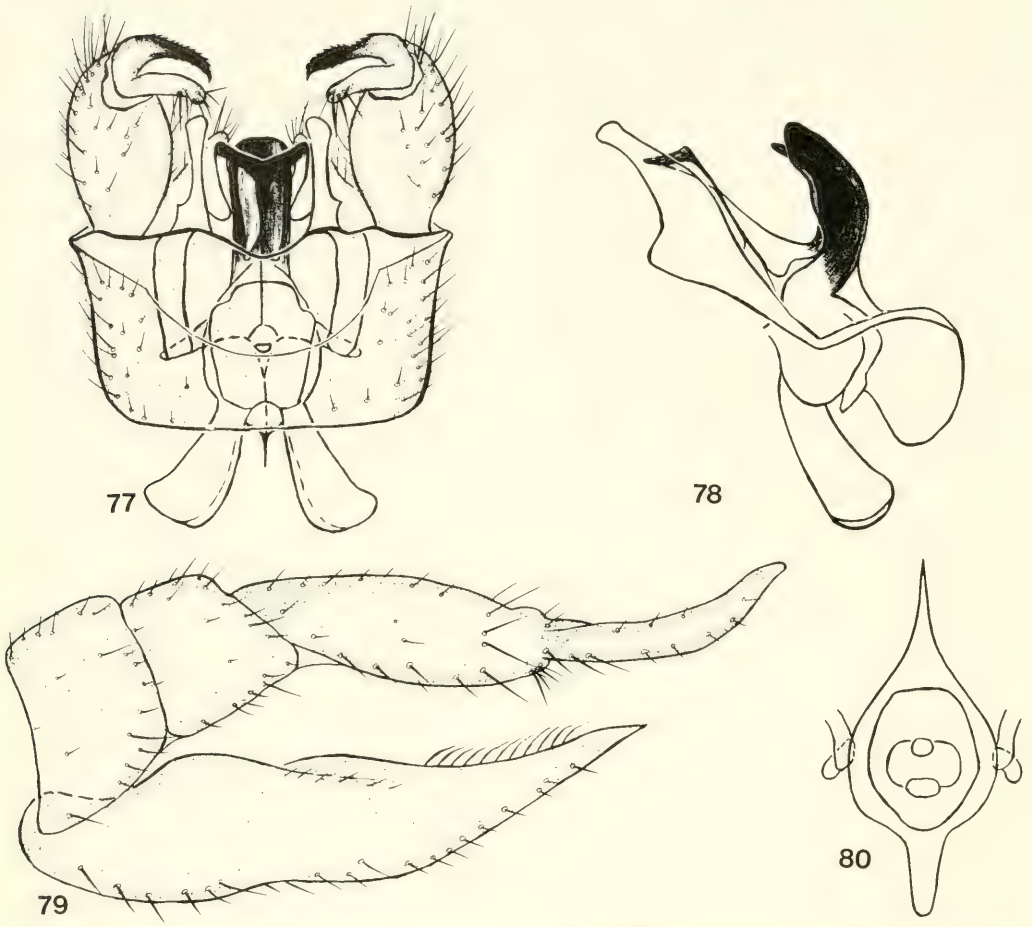
COMPARATIVE NOTES. D. sobrina can be easily separated from other species except *nigripes* and *tigrina* by having banded abdominal sterna, but it differs from both those species in the location of the bands. In *D. sobrina* each sternum has an anterior dark transverse band while in *nigripes* and *tigrina* the dark band is at the middle of each sternum. *D. sobrina* can also often be recognized by its conspicuous dark brown fore femora, although this character is not constant. Most specimens are grayish brown with dark brown only on the fore femora. However, there is variation in over-all body coloration and the color of the femora. The specimens from Illinois, Kansas and Missouri, that is from the western part of the range, have yellowish brown body color and are uniformly light brown on all the femora. Members of the Florida population, which was described as *D. rogersi,* have an over-all dark brown body color and with dark brown on all the femora. Although the species varies in body color, banded abdominal sterna are persistent in all the populations. Having examined the type series of *D. rogersi* and specimens from other Floridian localities, I feel certain that *rogersi* is only an extreme color variant of *sobrina.*

GEOGRAPHIC AND SEASONAL DISTRIBUTION. D. sobrina is the most widespread species of the genus. Its range extends from Maryland westward to eastern Kansas and southward through the Appalachian Mountains into central Florida (Map 9). *D. sobrina* has a late spring flight period in most of its range, except for the Florida population, where it was collected in late April and early May. In eastern Kansas, *D. sobrina* emerges in mid June and disappears by late June, while in most of the southeastern states occurrence of adults fly between late May and early June.

Summary of distribution: Alabama - Bibb Co., 25 May; De Kalb Co., 3 June;



MAP 9. Known distribution of *Dicranoptycha sobrina.*



FIGURES 77-80. *Dicranoptycha (D.) sobrina.* 77, male hypopygium, dorsal aspect. 78, left lateral aspect with external skeleton removed. 79, female hypopygium, left lateral aspect. 80, postero-ventral aspect.

Lee Co., 26 May. Florida - Jackson Co., 13 April to 9 May; Marion Co., 13 April. Georgia - Fulton Co., 1 June; Murray Co., 20 May; Whitfield Co., 27 May. Illinois - Effingham Co., 10 June. Indiana - Harrison Co., 13-18 June; Jefferson Co., 16 June; Marrion Co., 12 June; Owen Co., 24 June; Parke Co., 16 June; Spencer Co., 11 June. Kansas - Douglas Co., 15 June to 29 June. Kentucky - Christian Co., 3 June; Scott Co., 3 June. Maryland - Montgomery Co., 5 June; Prince Georges Co., 29 May to 1 June. Mississippi - Lee Co., 24 May. Missouri -Carter Co., 4 June. North Carolina - Buncombe Co., 29 May to 24 June; Jackson Co., 1 July; Transylvania Co., 5-10 June; Watauga Co., 22 June. Ohio - Athens Co., 12 June; Delaware Co., 15 June; Meigs Co., 4 June. South Carolina - Abbeville Co., 29 May; Spartanburg Co., 2 June. Tennessee - Fentress Co., 14-19 June; Grundy Co., 19 May; Morgan Co., 19 June; Scott Co., 29 May. Virginia - Floyd Co., 23 June; Giles Co., 18 June to 2 July; Prince William Co., 3 July.

Dicranoptycha (Dicranoptycha) spinifera, new species

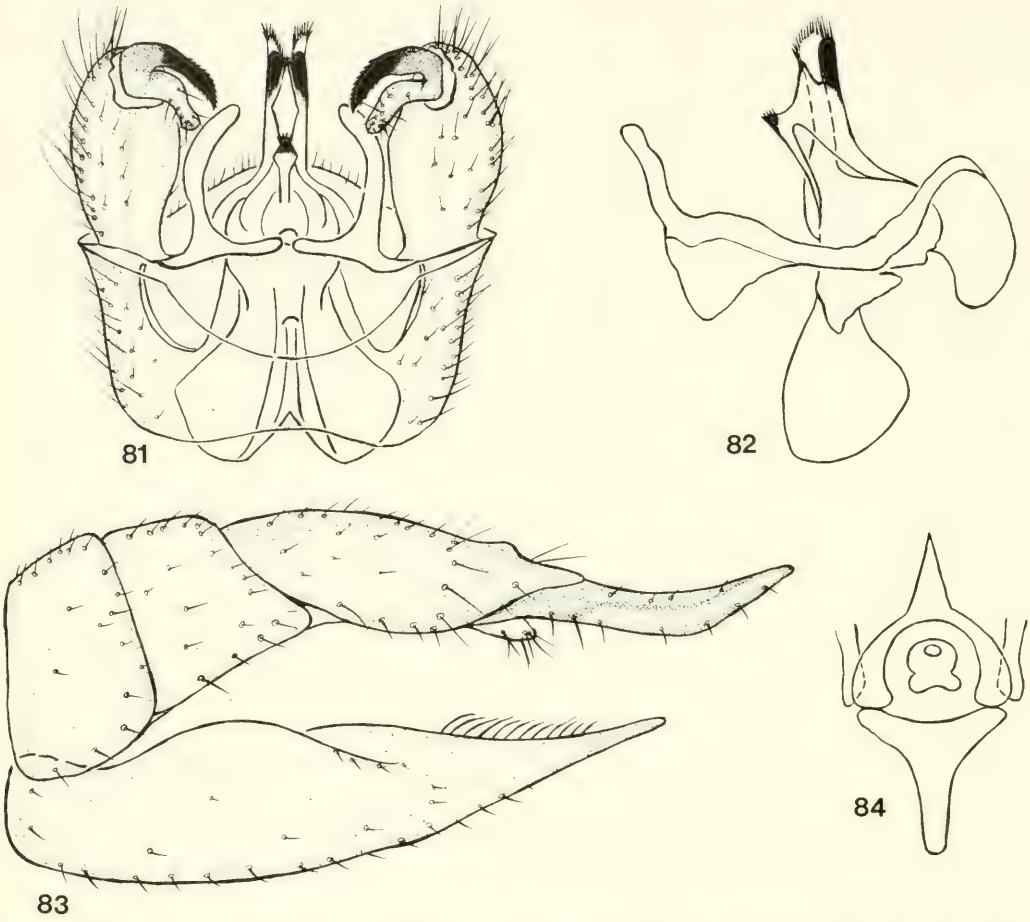
TYPES. Holotype, male, White Rock Ranch, White Rocks Forest Service Campground, near Kire, Giles County, Virginia, 3 June 1977, C.-W. Young 2. Allotype, taken in copulation with the holotype. Paratypes, 14 males and 8 females from vicinity of Mountain Lake Biological Sta-

tion, Giles County, Virginia, as follows: 24 June 1935, 1 male, 1 female; 25 June 1935, 2 females; 27 June 1935, 1 male; 28 June 1935, 1 female; all collected by R. E. Bellamy; 31 May 1946, 1 male; 4 June 1946, 2 males, 1 female; 6 June 1946, 3 males; 7 June 1946, 2 males, 1 female; 8 June 1946, 1 male, 1 female; 11 June 1946, 1 female; 25 June 1946, 1 male; all collected by J. S. Rogers; 23 June 1969, 1 male, collected by G. W. Byers; 3 June 1977, 1 male, collected by C.-W. Young. Specimens from elsewhere in the Appalachian region have not been included in the type series. The paratypes in the University of Michigan Museum of Zoology, collected by Bellamy and Rogers, had been determined by the latter as *D. acanthophallus.* Holotype, allotype and two male paratypes are in SEM. The rest of the paratypes are in UMMZ. The specific name refers to the spinose aedeagus of males.

Description. General coloration dark brown. Male body length 8.5-9 mm, wing 11 mm. Female body length 9.5-11 mm, wing 12 mm. *Head* gray, with one row of blackish bristles around each eye. Rostrum gray, palpi dark brown. Antennae with scape, pedicel and basal four flagellomeres yellow, outer flagellomeres brown. Scape oblong, twice as long as subspherical pedicel; flagellomeres longoval, their verticils conspicuous; first four flagellomeres each bearing 2 setae, fifth and subsequent each with four or five setae. *Thorax* mostly dark brown, with dense gray pollinosity, especially on pleura. Mesonotum dark gray, prescutum with indistinct median blackish gray stripe; pseudosutural foveae polished black. Wings smoky yellow with distinct brown seam along entire length of vein Cu. Veins testaceous, with setae on all longitudinal veins except 2A. Halteres pale throughout. Legs with coxae yellow. Trochanters yellow, femora and tibiae yellow to testaceous with brown tips. Basitarsi testaceous; tarsomeres dark brown. *Abdomen* dark brown, male hypopygium (Fig. 85) brown, dorsal dististyle arcuate, apical half blackened and strongly denticulate on all surfaces. Ventral dististyle broad at base, constricted before slightly dilated apex. Male genitalia (Fig. 86) with vesica oval, lateral processes conspicuous, extending to about three-fourths length of basistyle. Bases of lateral processes do not extend mesad and fuse to form dorsal bridge as in other species. Lateral apodeme broadly expanded in upper part. Anterior apodemes broad, fused medially along basal two-thirds of their length, apical one-third, forming two broad lobes. Ventral apodeme keel-like, well developed. Aedeagus conspicuous, elongate, with numerous distiinct spines at apex. Aedeagal process with narrowed, pointed upper part, dark, spiny, at posterior end connected beneath it a diamond-shaped lower part bent downward above aedeagus. Female genitalia (Fig. 87) of *germana* form; cerci about same length as tenth tergum, widest near mid-length, then evenly narrowed to apex; twelve setae on inner dorsal edge of each hypovalve. Postero-ventral aspect of external reproductive structures as in Fig. 88.

Comparative Notes. This species has been confused with *D. acanthophallus* because of the similarity in general appearance and because the original description of *acanthophallus* stated ". . . aedeagus stout and massive, near apex provided with more than a score of conspicuous erect spines." Alexander ordinarily described the terminal abdominal structures from slide-mounted specimens examined by compound microscope. Accordingly, the "conspicuous spines" on the aedeagus of *D. acanthophallus,* while distinct with such high magnification, are barely visible when viewed with a hand lens or stereoscopic dissecting microscope. *D. spinifera* can be easily separated from *acanthophallus* by visible spines at the tip of the aedeagus; by the narrowed, pointed upper part of the aedeagal process; and by its long and slender lateral process (Fig. 85) compared to that of *acanthophallus* (Fig. 37). *D. spinifera* also shows affinity with *byersi* in having a distinct brown seam along the entire length of vein Cu (see discussion under *byersi*). Females of these three species are less readily differentiated by external characters and can most reliably be separated by the structure of the ninth abdominal sternum and genital furca.

Geographic and Seasonal Distribution. *D. spinifera* is known from Pennsylvania to northern Georgia, where it is often found in the low Appalachian valleys (May 7). The types were collected in woods which included oaks, maple, yellow birch, hemlock, *Rhododendron,* tulip trees; understory of *Kalmia,* azaleas, abundant alder, locally deep growth of fern, skunk cabbage, and greenbriar. This is a late spring to early summer species. Rogers' collection from near Mountain Lake Biological Station,



FIGURES 81-84. *Dicranoptycha (D.) spinifera*. 81, male hypopygium, dorsal aspect. 82, left lateral aspect with external skeleton removed. 83, female hypopygium, left lateral aspect. 84, postero-ventral aspect.

Giles County, Virginia, indicates a flight period from late May to late June.

Summary of distribution: Georgia - Towns Co., 30 May; White Co., 1 June. North Carolina - Ashe Co., 27 June; Avery Co., 1 June; McDowell Co., 8 June; Watauga Co., 22 June; Yancey Co., 8 June. Pennsylvania - Lackawanna Co., 12 June. Tennessee - Sevier Co., 10 June. Virginia - Floyd Co., 23 June; Giles Co., 27 May to 27 June.

Dicranoptycha (Dicranoptycha) tennessa Alexander

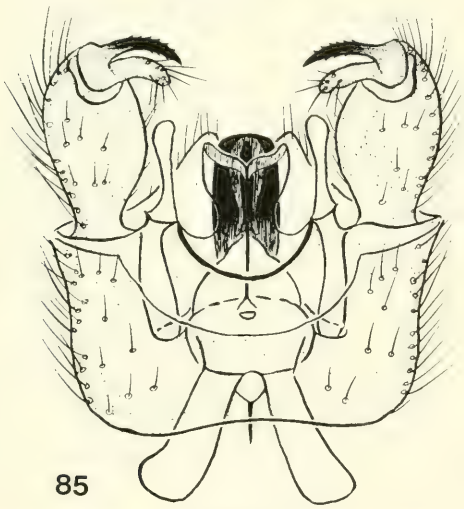
Dicranoptycha tennessa Alexander, 1941, Entomol. News. 52: 195.

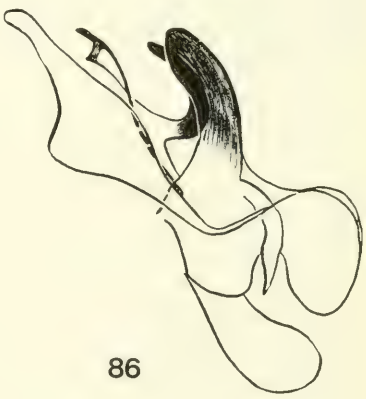
TYPES. Holotype, male, Knoxville, Knox County, Tennessee, 10 June 1939, A. C. Cole. Allotype, same data as holotype, and pinned with holotype. Both holotype and allotype are in the collection of C. P. Alexander, NMNH. The holotype is mounted on a microscope slide.

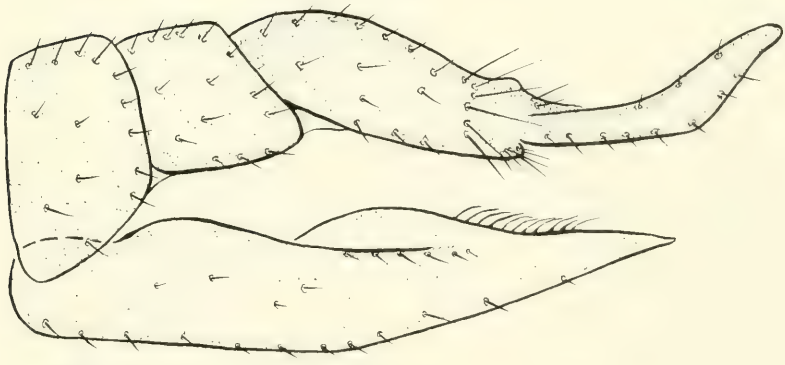
TAXONOMIC CHARACTERISTICS. General coloration grayish brown. Male body length 8-8.5 mm, wing 8.5 mm. Female body length about 9 mm, wing 9.5 mm. *Head* gray with one row of brown bristles around each eye. Rostrum dark brown, palpi brown. Antennae with yellowish scape and pedicel, flagellomeres brown. Verticils long, about three times length of their respective flagellomeres. *Thorax* with grayish brown nota and grayish pleura, densely pruinose on all surfaces. Prescutum without distinct longitudinal stripes.

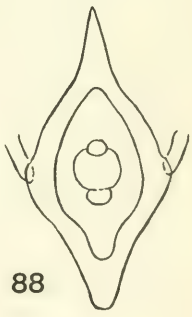
Pseudosutural foveae polished black. Wings with yellowish tinge, costal fringe long and conspicuous, 2A without setae. Legs with coxae testaceous yellow, trochanters obscure yellow. Remainder of legs light brown. *Abdomen* with terga brown, sterna brownish yellow. Male with darkened sixth, seventh and eighth segments and yellow hypopygium. Hypopygium (Fig. 85) with dorsal dististyle denticulate on outer two-thirds. Ventral dististyle evenly and slightly curved with blunt apex. Male genitalia (Fig. 86) with roughly oval vesica. Lateral process extending slightly beyond mid-length of basistyle. Lateral apodeme broad in upper part. Anterior apodemes separated at base, extending anteriorly into eighth segment. Ventral apodeme large, keel-like. Aedeagus of *sobrina* form, large, conspicuous, dorsoventrally flattened with broad, rounded apex. Aedeagal process with flattened upper part darkened at posterior margin, hook-like lower part bent downward then curved upward, attached to aedeagus at base. Female genitalia (Fig. 87) of *germana* form. Cerci slender at base, slightly broadened just beyond mid-length, then narrowed toward tips. Hypovalves extending slightly beyond mid-length of cerci, eleven setae on inner dorsal edge of each hypovalve. Postero-ventral aspect of female genitalia shows receptacle of aedeagal process beneath aperture of bursa copulatrix (Fig. 88).

COMPARATIVE NOTES. D. tennessa has been misidentified as *sobrina* in some collections. Both species have long and conspicuous costal fringes and massive aedeagi. However, *D. tennessa* can be readily distinguished









FIGURES 85-88. *Dicranoptycha (D.) tennessa.* 85, male hypopygium, dorsal aspect. 86, left lateral aspect with external skeleton removed. 87, female hypopygium, left lateral aspect. 88, postero-ventral aspect.

by its smaller body size and unbanded abdominal sterna. The similarity in male genitalia in these two species and *D. megaphallus* is discussed under *D. megaphallus*.

GEOGRAPHIC AND SEASONAL DISTRIBUTION. *D. tennessa* was previously known only from the type locality. The present study shows that *D. tennessa* has a wide range, from Pennsylvania southward to western Alabama (Map 10). It has a late May to mid June flight period in the southern part of its range and a mid June to early July one in the northern part.

Summary of distribution: Alabama - Hale Co., 26 May; Fayette Co., 24 May. Kentucky - Spencer Co., 6 June. North Carolina - Johnston Co., 28 May. Pennsylvania - Berks Co., 9 July; Lancaster Co., 12 July. South Carolina - Abbeville Co., 29 May. Tennessee - Knox Co., 10 June; Sevier Co., 13-17 June; Wilson Co., 4 June. Virginia - Giles Co., 26 June to 15 July; Prince William Co., 6 July. West Virginia - Greenbrier Co., 1 July.

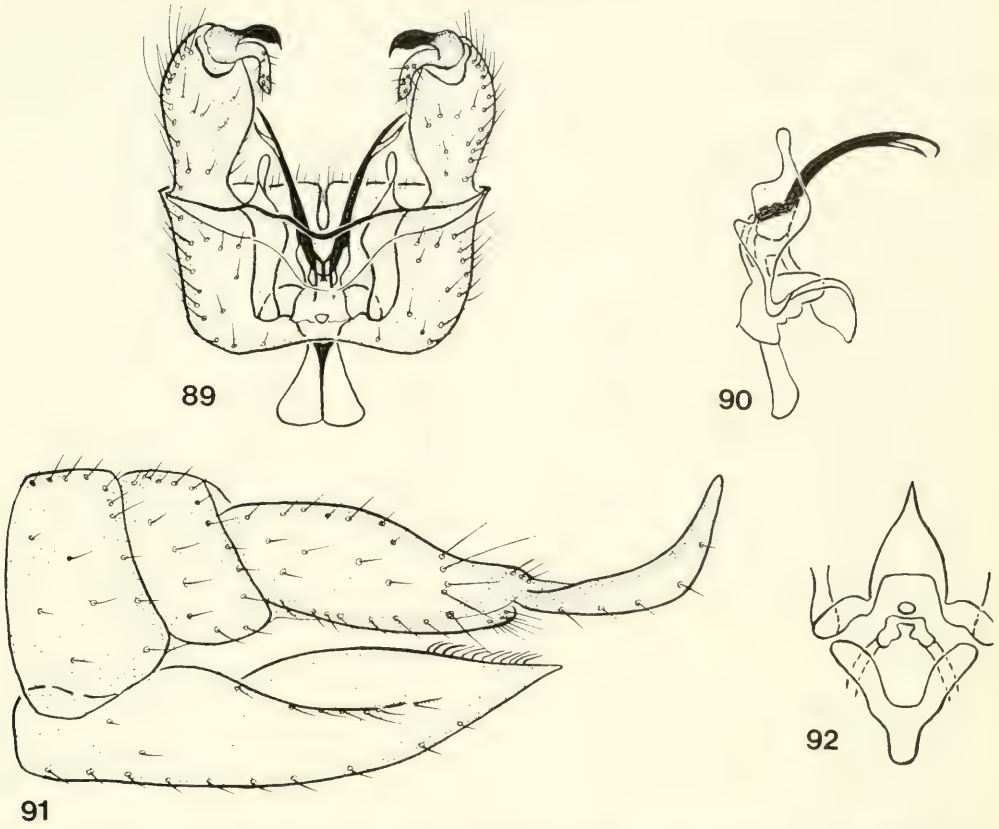
MAP 10. Known distribution of *Dicranoptycha tennessa*.

Dicranoptycha (Dicranoptycha) tigrina Alexander

Dicranoptycha tigrina Alexander, 1919, Entomol. News, 30: 21.

TYPES. Holotype, male, Lawrence, Douglas County, Kansas, altitude 900 feet, 16 July 1918, C. P. Alexander. Allotype, same data as holotype. Paratypes 50 males and females from 16 to 30 July 1918; no detailed data about the numbers of each sex were mentioned. Holotype, allotype and eight male and eleven female paratypes are in the collection of C. P. Alexander, NMNH. One male paratype is in the British Museum (Natural History), London. Two female paratypes are in SEM. One male and four female paratypes are in UMMZ. One male paratype is in CAS. The location of other paratypes is unknown. The holotype and three male paratypes are mounted on microscope slides.

TAXONOMIC CHARACTERISTICS. General coloration grayish brown. Male body length about 8 mm, wing 8.5 mm. Female body length 9 mm, wing 9 mm. *Head* dark brown, with one row of black bristles around each eye. Rostrum brownish yellow, palpi black. Antennae with yellow scape and pedicel, flagellomeres dark brown. Verticils short, slightly longer than their respective flagellomeres. *Thorax* grayish brown, prescutum brown with golden pruinosity, without longitudinal stripes, pleuron heavily covered with gray pruinosity. Pseudosutural foveae reddish brown. Wings with borwn tinge, highly iridescent under light at certain angles, costal fringe short. Legs with coxae brownish yellow, slightly pruinose at bases, trochanters and femora brownish yellow, tips of femora brown, tibiae and tarsomeres light brown. *Abdomen* with terga dark brown, the apical one-fifth of each segment more yellowish, sterna yellowish, segments three to seven with transverse blackened band near mid-length. Both terga and sterna producing a banded appearance. Male with darkened subterminal ring on seventh segment. Male hypopygium (Fig. 89) yellow. Dorsal dististyle constricted at about mid-length and arcuate to acute tip, both inner and outer curves glabrous. Ventral dististyle longer than dorsal one, strongly arcuate before mid-length. Male genitalia (Fig. 90) with small vesica. Lateral process short, extending slightly beyond one-fourth length of basistyle. Both upper and lower parts of lateral apodeme expanded. Anterior apodemes almost totally fused along mid-line, narrowed at base and expanded anteriorly, with slight notch at line of fusion. Ventral apodeme keel-like, well developed. Aedeagus inconspicuous both in dorsal and lateral aspects. Two long slender aedeagal processes arising from base of aedeagus, bent ventrad and branched near their tips. Female genitalia (Fig. 91) of *germana* form. Cerci slightly shorter than tenth tergum, narrowed at base, slightly broadened at mid-length and then narrowed toward upwardly curved tips. Hypovalvae reaching to about one-fourth length of cerci, twelve setae on inner dorsal edge of each hypovalve. Postero-ventral aspect of external reproductive structures as in Fig. 92, with long receptacles for branches of aedeagal process.



FIGURES 89-92. *Dicranoptycha (D.) tigrina*. 89, male hypopygium, dorsal aspect. 90, left lateral aspect with external skeleton removed. 91, female hypopygium, left lateral aspect. 92, postero-ventral aspect.

COMPARATIVE NOTES. D. tigrina may be readily separated from the other two species with banded abdomen by having this striped, or tigrine appearance on both the terga and sterna of the abdomen. In the structure of the male genitalia, it is apparently close to *D. nigripes*. Differentiating the males of these two species is discussed under *D. nigripes*. Females of these two species can be separated by the structure of the receptacle for the aedeagal process, which in *D. tigrina* has a secondary branch near the tip (Fig. 92) and in *nigripes* near mid-length (Fig. 68).

GEOGRAPHIC AND SEASONAL DISTRIBUTION. D. tigrina is known from Pennsylvania southward to North Carolina and southwestward to southern Oklahoma, widely spread from the Appalachian Mountains to the eastern plains and Ozark Mountain regions (May 6). In the discussion of *D. nigripes* I considered that *nigripes* and *tigrina* are closely related species that have excluded each other from their respective ranges. They both have about the same flight season, and examination from J. S. Rogers' extensive collections in Haywood County, North Carolina, and Giles County, Virginia, showed that all specimens collected were *D. tigrina*. It is a late summer, early fall species; in eastern Kansas it has a flight period from late August to mid September. It was often collected together with *D. septemtrionis*.

Summary of distribution: Arkansas - Polk Co., 30 July. Indiana - Jefferson Co., 27 August. Kansas - Douglas Co., 31 August to 20 September. Missouri -Miller Co., 23 August. North Carolina - Haywood Co., 27

July to 3 August. Oklahoma - Marshall Co., 2 July. Pennsylvania - Delaware Co., 25 August. Tennessee - Cumberland Co., 14 July. Virginia - Giles Co., 21-30 August.

Dicranoptycha (Dicranoptycha) winnemana Alexander

Dicranoptycha winnemana Alexander, 1916, Proc. Acad. Nat. Sci. Philadelphia, 1916: 500.

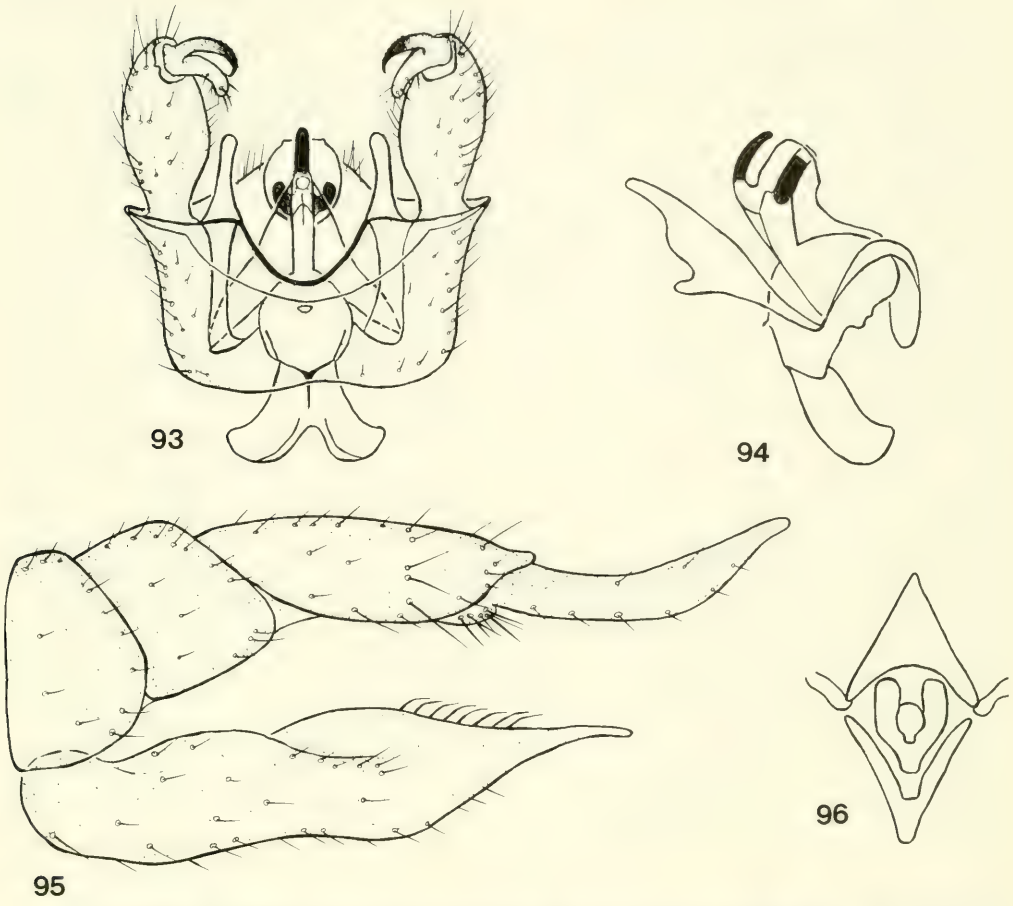
Types. Holotype, male, Plummers Island (or Winnemana, as the Indians called the island), Maryland, 21 July 1915, C. P. Alexander. Allotype, same data as holotype. Alexander (1916: 500) listed "paratopotypes, one male and ten females (McAtee and Alexander); paratype, one female, Dead Run, Virginia, July 21, 1915 (McAtee); one male, Lost Mountain, Cobb County, Georgia, July 13, 1913 (Bradley)." Holotype, allotype and most of the paratypes are in the collection of C. P. Alexander, NMNH. One female paratype is in CU (3483). The holotype and two male paratypes are mounted on microscope slides.

Taxonomic Characteristics. Basic coloration pale brownish yellow. Male body length 7-7.5 mm, wing 7.5 mm. Female body length 7.5-8.5 mm, wing 8-8.5 mm. *Head* ochraceous, with two rows of long bristles around each eye. Rostrum and palpi brown. Antennae with scape and pedicel dark brown, flagellomeres light brown. Verticils long, about twice length of their respective flagellomeres. *Thorax* pale brownish yellow with grayish pruinosity on pleura. Prescutum light brownish yellow, without stripes. Pseudosutural foveae dull yellow. Wings pale yellow, with setae on all longitudinal veins except 2A, costal fringes long and conspicuous, especially in males. Legs with coxae, trochanters, femora, tibiae and basitarsi yellow, outer four tarsomeres light brown. *Abdomen* brownish yellow. In male, seventh segment dark brown, forming subterminal ring, eighth segment and hypopygium brownish yellow. Male hypopygium (Fig. 93) with dorsal dististyle arcuate at apex, apex sharply pointed, outer curve slightly denticulate. Ventral dististyle larger than dorsal one, apex rounded but not enlarged. Male genitalia (Fig. 94) with vesica broadly oval. Lateral process with rounded apex, reaching to about mid-length of basistyle. Anterior apodemes well developed, fused for about half their length, broad at base, expanded and curved laterad anteriorly. Ventral apodeme small, keel-like. Both upper and lower parts of lateral apodeme equally expanded. Aedeagus short, with one short, darkened branch on each side. Aedeagal process with rod-like, darkly sclerotized upper part bent ventrad and connected anteriorly to enlarged lower part, which encloses aedeagus dorsally and laterally. Female genitalia (Fig. 95) of *germana* form. Cerci about same length as tenth segment, curved upward and narrowed at tips. Hypovalves with acuminate tips extending to about mid-length of cerci; eight setae on inner dorsal edge of each hypovalve. In postero-ventral aspect of external reproductive structures, receptacle of aedeagal process visible beneath and around sides of aperture of bursa copulatrix (Fig. 96).

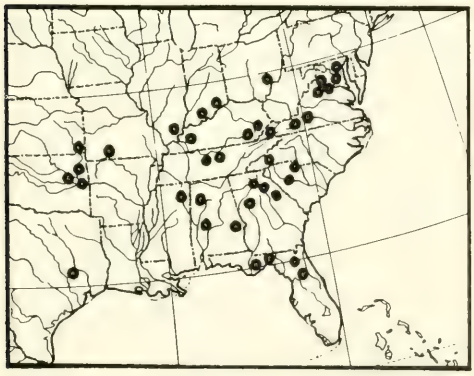
Comparative Notes. D. winnemana is the palest species in this genus in eastern North America. The only species with which it might be confused on the basis of color is *D. pallida*. For differentiation of these species see the discussion of the latter. Males of *D. winnemana* can be distinguished by the conspicuous genitalial characters, especially the enlarged lower part of the aedeagal process.

Geographic and Seasonal Distribution. D. winnemana is one of the more widespread species, its range approximating that of *sobrina*. *D. winnemana* occurs from Maryland to eastern Oklahoma and Texas and southward into western and central Florida (Map 11). It is a spring species. Its flight season starts in April in Florida and ends in July in northern parts of the range. About 8:15 on the morning of 24 May 1978, about 20 mating pairs were collected at Tombigbee State Park, Lee County, Mississippi. They were found mostly in mixed woods—white oak, hickory, tulip tree, and ash, with some dogwood, sassafras, and mulberry; undergrowth of poison ivy, wild grape, wild rose, Virginia creeper, and green brier. Mating pairs were found about two feet above the ground on undergrowth leaves.

Summary of distribution: Alabama - Fayette Co., 24 May; Hale Co., 25 May; Lee Co., 26 May. Florida - Alachua Co., 26-30 May; Jefferson Co., 27 April; Leon Co., 16 April; Marion Co., 11 May. Georgia - Clarke Co., 29 May; Cobb Co., 13 June; Dawson Co., 22 June; Hall Co., 6 June. Illinois - Pope Co., 14 July. Indiana - Floyd Co., 17 July; Jefferson Co., 7 July. Kansas - Cherokee Co., 24 June. Kentucky -



FIGURES 93-96. *Dicranoptycha (D.) winnemana.* 93, male hypopygium, dorsal aspect. 94, left lateral aspect with external skeleton removed. 95, female hypopygium, left lateral aspect. 96, postero-ventral aspect.



MAP 11. Known distribution of *Dicranoptycha winnemana.*

Bell Co., 18 June; Christian Co., 12 June; Whitley Co., 24 June. Maryland - Montgomery Co., 30 June. Mississippi - Lee Co., 24 May. Missouri - Taney Co., 12 June. North Carolina - Haywood Co., 20 June. Ohio - Athens Co., 21 July. Oklahoma - Adair Co., 17 June; Delaware Co., 10 June; Le Flore Co., 23 June; Rogers Co., 19 June. South Carolina - Abbeville Co., 30 May; Spartanburg Co., 2-5 June. Tennessee - Fentress co., 28 June; Wilson Co., 20 June. Texas -Brazos Co., 10 May. Virginia - Fairfax Co., 23 July; Giles Co., 9-15 July; Greene Co., 14 July; Montgomery Co., 15 July; Rappahannock Co., 30 June; Shenandoah Co., 5 July; Washington Co., 30 June.

THE *MELAMPYGIA* GROUP

Dicranoptycha (Dicranoptycha) melampygia Alexander

Dicranoptycha melampygia Alexander, 1950, Pan-Pacific Ent. 26: 81.

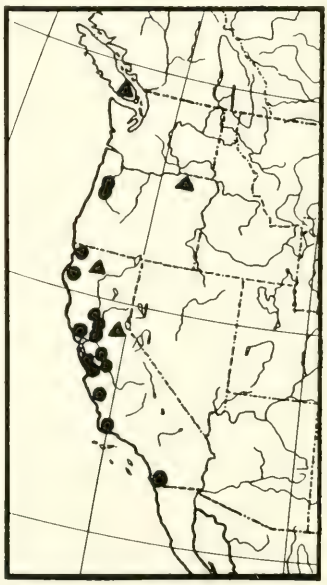
TYPES. Holotype, male, Prairie Creek State Park, Humboldt County, California, 11 August 1948, C. P. Alexander. Three male and one female paratypes, Peavine Ridge, Yamhill Co., Oregon, 12 July 1945, K. M. Fender; one male paratype from Zena, Eola Hills, Polk County, Oregon, 5 June 1940, K. M. Fender. All types are in the collection of C. P. Alexander, NMNH. The holotype and three male paratypes are mounted on microscope slides.

TAXONOMIC CHARACTERISTICS. General coloration brown. Male body length 8.5-9 mm, wing 8-9 mm. Female body length 9-9.5 mm, wing 9.5 mm. *Head* dark gray, with one row of brown bristles around each eye. Rostrum brown, palpi dark brown. Antennae with scape and pedicel obscure yellow, flagellomeres dark brown. Verticils about one and a half times the length of their respective flagellomeres. *Thorax* brown, with golden pruinosity on nota and gray pruinosity on pleura. Prescutum without longitudinal stripe. Pseudosutural foveae brown. Wings with brown tinge, costal fringe short and dense. Legs with coxae brown, pruinose, trochanters and femora obscure yellow, tibiae and tarsi brown. *Abdomen* dark brown, without subterminal ring. Male hypopygium (Fig. 97) with dorsal dististyle evenly curved, gradually narrowed to slender apical spine, outer curvature denticulate. Ventral dististyle broad at base, narrowed near mid-length, with obtusely rounded apex. Male genitalia (Fig. 98) with small vesica. Lateral process reaching to about mid-length of basistyle, with flange on outer apical margin of acute, outwardly curved tip. Both upper and lower parts of lateral apodemes expanded. Anterior apodemes fused medially for most of their length with dorsal crest formed along line of fusion, their combined bases about same width as vesicle, widened and rounded anteriorly, with slight median notch. Ventral apodeme small, aedeagus short. Aedeagal process flat, platelike, connected medially to top of aedeagus. Female genitalia (Fig. 99) with cerci short, broad, spatulate, shorter than tenth tergum. Very long hairs around posterior end of tenth tergum and on margin of slightly expanded cercal base. Hypovalves extending to about base of cerci, eleven setae on inner dorsal edge of each hypovalve. Postero-ventral aspect of external reproductive structures, as in Fig. 100, ninth sternum and genital furca fused together.

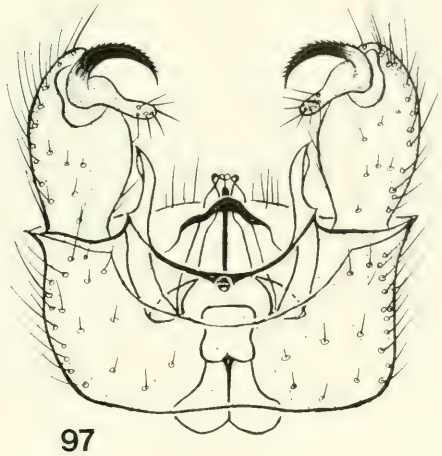
COMPARATIVE NOTES. This species and *D. occidentalis* are closely related. However, *D. melampygia* may be distinguished from *occidentalis* by the dark brown body color, dense costal fringe, and detailed structure of the male genitalia. The similarity between *D. melampygia* and *nigrogenualis* is covered in the discussion of the latter.

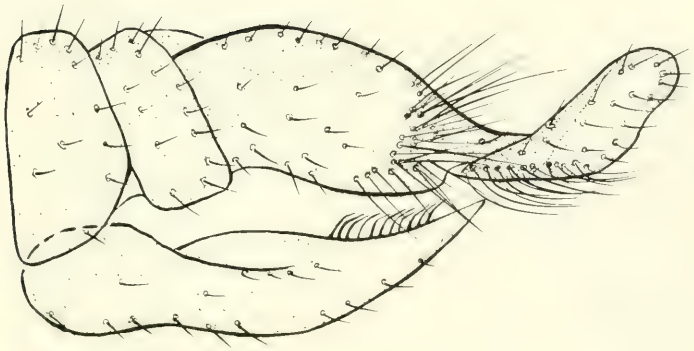
GEOGRAPHIC AND SEASONAL DISTRIBUTION. *D. melampygia* is known from the Coast Ranges from southern California to northern Oregon (Map 12). Its range overlaps that of *D. occidentalis* in California, but intermediate specimens are unknown. Specimens have been collected from early April to mid July. All April records are from low altitudes in southern California.

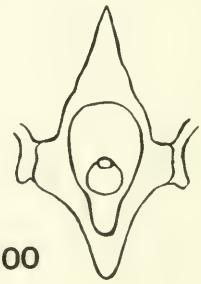
Summary of distribution: California - Alameda Co., 4-14 May; Contra Costa Co., 13 May; Del Norte Co., 19-22 June; Humboldt Co., 27 May; Marin Co., 13-25 May, 1 June; Monterey Co., 8 May to 1 June; Napa Co., 9 May; San Diego Co., 10-21 April; San Mateo Co., 16 May; Santa Barbara Co., 18-21 May; Santa Clara Co.,



MAP 12. Known distribution of *Dicranoptycha melampygia* (circles) and *D. spinosissima* (triangles).







FIGURES 97-100. *Dicranoptycha (D.) melampygia.* 97, male hypopygium, dorsal aspect. 98, left lateral aspect with external skeleton removed. 99, female hypopygium, left lateral aspect. 100, postero-ventral aspect.

3 June; Santa Cruz Co., 2 June; Sonoma Co., 8 May. Oregon - Polk Co., 5 June, Yamhill Co., 12 July.

Dicranoptycha (Dicranoptycha) nigrogenualis Alexander

Dicranoptycha nigrogenualis Alexander, 1949, Amer. Midland Nat., 42: 291.

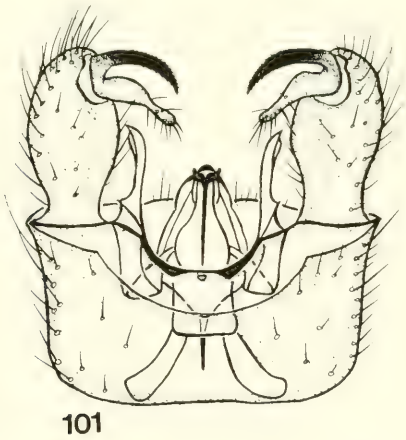
TYPES. Holotype male, Boulder Lake trail from Olympic Hot Springs, Olympic National Park, altitude 3,400 ft., Clallam County, Washington, 5 August 1947, M. M. Alexander. Allotype, Sahale Falls, Mount Hood, altitude 4575 ft., Hood River County, Oregon, 17 July 1947, C. P. Alexander. Types are slide-mounted and are in the collection of C. P. Alexander, NMNH.

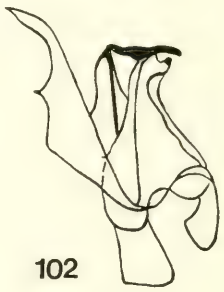
TAXONOMIC CHARACTERISTICS. General coloration dark brown. Male body length about 11 mm, wing 11 mm. Female body length 11.5 mm, wing 11 mm. *Head* dark gray, with one row of dark bristles around each eye. Rostrum and palpi dark brown. Antennae with scape brown, pedicel obscure yellow, flagellomeres brown. Verticils about one and a half times length of their respective flagellomeres. *Thorax* with prescutum dark brown, without longitudinal stripes, pleura uniformly reddish brown with gray pruinosity. Pseudosutural foveae polished black. Wings brownish yellow, costal margin darker with short fringe, vein 2A without setae. Legs with coxae, trochanters yellow, femora yellow, apical one-fourth conspicuously blackened, tibiae brownish yellow, basitarsi light brown, outer tarsomeres dark brown. *Abdomen*

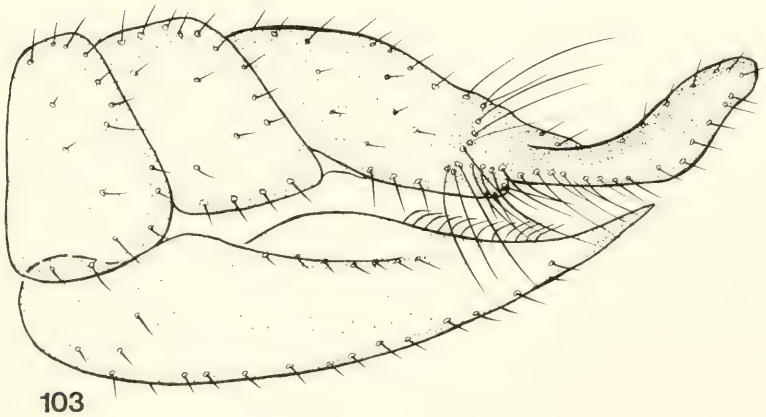
black, sparsely pruinose hypopygium. Male hypopygium (Fig. 101) brown with dorsal dististyle long, slender, narrowed toward tip denticulate on distal two-thirds. Ventral dististyle with basal half stout, outer half narrowed to rounded apex. Male genitalia (Fig. 102) with lateral process slender, with spine-like tip directed laterad, outer margin with low flange. Lateral apodeme slightly expanded in upper part. Anterior apodemes widely separated at base, diverging from anterior corners of somewhat quadrate vesica. Ventral apodeme keel-like, well developed, slightly smaller than anterior apodeme. Aedeagus short, inconspicuous, with two tiny, sclerotized lobes at lower end. Aedeagal process with flat, plate-like upper part (phallosome, Alexander 1949), darker at posterior margin connected posteriorly to bar-like lower part hanging down behind aedeagus.

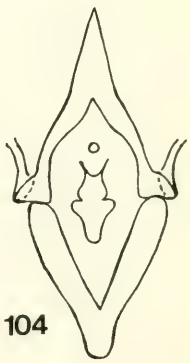
Female genitalia (Fig. 103) of *melampygia* form. Cerci slightly shorter than tenth segment, narrowed at base and broadly expanded beyond mid-length, with blunt tips. A circle of long setae near posterior end of the tenth segment. Hypovalves sharp-tipped, reaching approximately to mid-length of cerci. Twelve setae on inner dorsal edge of each hypovalve. Postero-ventral aspect of external reproductive structure shows slightly sclerotized receptacle for aedeagal process below aperture of bursa copulatrix (Fig. 104).

COMPARATIVE NOTES. D. nigrogenualis is differentiated from *stenophallus* and *spinosissima* by its larger body size, by its overall darker color, and by having a flange on the outer margin of the lateral process. Although the widely spaced anterior apodemes separate









FIGURES 101-104. *Dicranoptycha (D.) nigrogenualis.* 101, male hypopygium, dorsal aspect. 102, left lateral aspect with external skeleton removed. 103, female hypopygium, left lateral aspect. 104, postero-ventral aspect.

males of this species from all other western species, they are not visible except in specimens that have been cleared.

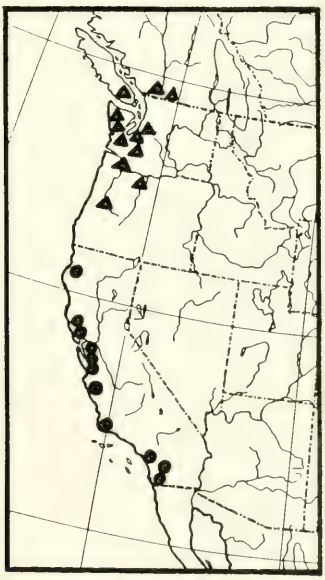
GEOGRAPHIC AND SEASONAL DISTRIBUTION. *D. nigrogenualis* has been recorded from southern British Columbia to Oregon, mainly in the Coast Ranges (Map 13). Examination of a series of specimens of this species (UMMZ) shows it has a mid-summer flight season.

Summary of distribution: British Columbia - Abbotsford, 27 June; Vancouver, 21 July; Vancouver Island, 31 July to 13 August. Oregon - Benton Co., 26 July; Hood River Co., 28 June. Washington - Clallam Co., 5 August; Cowlitz Co., 17 July; Grays Harbor Co., 12 July; Jefferson Co., 27 July; King Co., 19 July; Lewis Co., 2-12 July; Thurston Co., 28 July.

Dicranoptycha (Dicranoptycha) occidentalis Alexander

Dicranoptycha occidentalis Alexander, 1927, Proc. U. S. Natl. Mus., 72(2): 10.

TYPES. Holotype, male, Alpine, San Diego County, California, 10 April 1915, M. C. Van Duzee. Paratypes, two broken males, one from Muir Woods, Marin County, California, 19 May 1915, the other from Berkeley, Alameda County, California, 14 May 1915, both collected by M. C. Van Duzee. The holotype and paratypes are all mounted on microscope slides in the collection of C. P. Alexander, NMNH.

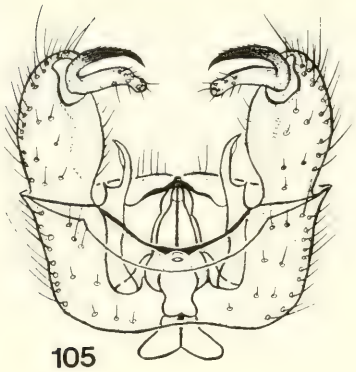


MAP 13. Known distribution of *Dicranoptycha nigrogenualis* (triangles) and *D. occidentalis* (circles).

TAXONOMIC CHARACTERISTICS. Basic coloration grayish yellow. Male body length 7.5-8 mm, wing 8.5 mm. Female body length 8.5-9 mm, wing 9 mm. *Head* ashy gray, with one row of brown bristles around each eye. Rostrum light brown, palpi dark brown. Antennae with scape and pedicel yellow, flagellomeres brown, verticils about same length as their respective flagellomeres. *Thorax* brownish yellow, prescutum with an obscure brown median line. Pseudosutural foveae indistinct. Wings with yellowish tinge, highly iridescent under light at certain angles, costal fringe short, 2A without setae. Legs and basitarsi yellow, four outer tarsomeres brown. *Abdomen* yellowish brown. In male, segments seven and eight forming darkened subterminal ring. Male hypopygium (Fig. 105) with dorsal dististyle slender, evenly curved to terminal spine, outer curvature denticulate. Ventral dististyle slightly larger than dorsal one, tapering slightly from base to rounded apex. Male genitalia (Fig. 106) with small vesica. Lateral process with flange on outer apical margin and acute tip curved laterad. Lateral apodeme broad in upper part. Anterior apodemes narrow at base, widened anteriorly, fused for more than half their length with crest along median line. Ventral apodeme small, poorly defined. Aedeagus blunt, without any projection. Aedeagal process flat, plate-like, connected medially to top of aedeagus. Female genitalia (Fig. 107) of *melampygia* form. Cerci shorter than tenth segment, long hairs along basal ventral margin and near posterior end of tenth segment. Hypovalve reaching approximately to base of cerci, eleven setae on inner dorsal edge of each hypovalve. Postero-ventral aspect of external reproductive structures as in Fig. 108.

COMPARATIVE NOTES. Specimens of this species and of *D. stenophallus* closely resemble each other externally. The specific characters that distinguish these species are covered in the discussion of the latter. The grayish yellow body color and the darkened subterminal ring separate males of *D. occidentalis* from those of *melampygia,* the only species with which it may be confused on the structure of male genitalia.

GEOGRAPHIC AND SEASONAL DISTRIBUTION.



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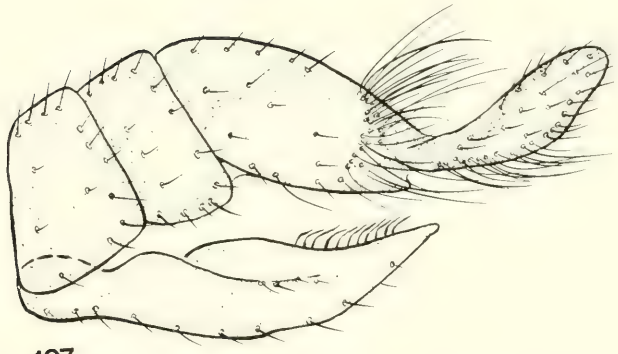

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FIGURES 105-108. *Dicranoptycha (D.) occidentalis.* 105, male hypopygium, dorsal aspect. 106, left lateral aspect with external skeleton removed. 107, female hypopygium, left lateral aspect. 108, postero-ventral aspect.

D. occidentalis is known only from California, along the Coast Ranges (Map 13). This species is closely related to *D. melampygia.* Specimens have been collected in habitats drier than that of *D. melampygia,* such as chaparral. The flight season starts in April in southern California and lasts into July in northern California.

Summary of distribution: California - Alameda Co., 21 June; Humboldt Co., 30 July; Los Angeles Co., 19 May, Marin Co., 19 May; Monterey Co., 1-20 June; Riverside Co., 29 April to 29 May; San Diego Co., 10 April; Santa Barbara Co., 18-21 May; Santa Clara Co., 29 April; Santa Cruz Co., 2 June; Sonoma Co., 8-17 July.

Dicranoptycha (Dicranoptycha) quadrivittata Alexander

Dicranoptycha sobrina quadrivittata Alexander, 1919, Canad. Entomol. 51: 191.

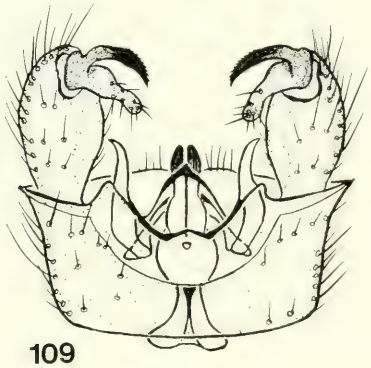
Dicranoptycha quadrivittata Alexander, 1927, Proc. U. S. Natl. Mus. 72(2): 10.

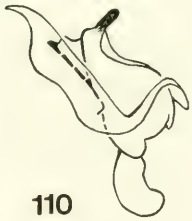
TYPES. Holotype, female, Peaceful Valley, Boulder County, Colorado, 25 August 1917, T. D. A. Cockerell. The holotype is in the collection of C. P. Alexander, NMNH.

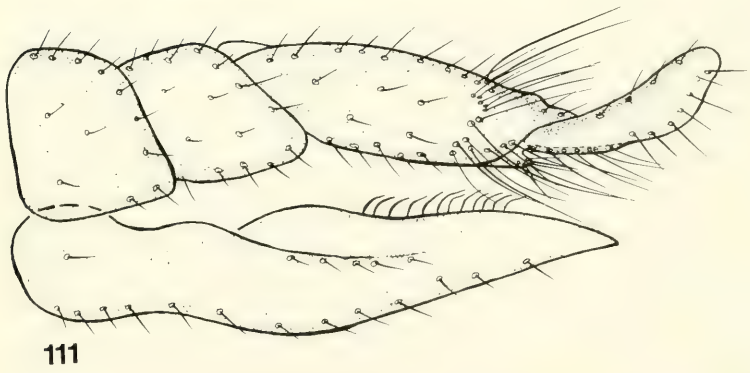
TAXONOMIC CHARACTERISTICS. Basic coloration gray. Male body length 8.5-9 mm, wing 9 mm. Female body length 9.5 mm, wing 10 mm. *Head* ashy gray, with one row of brown bristles around each eye. Rostrum grayish brown, palpi dark brown. Antennae with yellow scape and pedicel, flagellomeres dark brown. Verticils short, about same length as their respective flagellomeres. *Thorax* gray, with pruinosity on all surfaces. Prescutum gray, with four longitudinal stripes, median pair longest, dark brown, parallel and separated from each other by gray line, lateral stripes short, indistinct. Pseudosutural foveae reddish brown. Wings with tawny tinge, vein 2A without setae, costal fringe short. Legs with coxae gray, slightly pruinose,

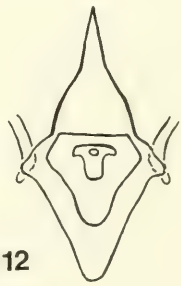
femora, tibiae and most of tarsi testaceous, apical tarsomeres brown. *Abdomen* with terga brown, sterna brownish yellow. Male with segments seven and eight dark brown, forming broad subterminal ring. Male hypopygium (Fig. 109) brown. Dorsal dististyle evenly curved to sharp apex, outer curvature denticulate. Ventral dististyle broad at base, abruptly narrowed at mid-length, apex rounded. Male genitalia (Fig. 110) with small vesica. Lateral process with pointed apex, curved laterad reaching to about mid-length of basistyle. Anterior apodemes small, about same size as vesica, fused medially, narrow at base, with slight indentation between them at anterior margin. Lateral apodeme narrow in lower part, upper part slightly expanded. Ventral apodeme small, keel-like. Aedeagus small, short, with two finger-like projections at its posterior end bent ventrad. Aedeagal process flattened, sinuate at sides and narrowed toward darker, pointed posterior margin, connected medially to top of aedeagus. Female genitalia (Fig. 111) of *melampygia* form. Cerci shorter than tenth segment, narrowed at base and expanded broadly near mid-length narrowing slightly toward rounded apex. Long setae around posterior end of tenth tergum and along margins of expanded cercal bases. Hypovalves reaching to about mid-length of cerci; twelve setae on inner dorsal edge of each hypovalve. Postero-ventral aspect of external reproductive structures as in Fig. 112, ninth sternum and genital furca fused together.

COMPARATIVE NOTES. The distinct grayish color of *D. quadrivittata* makes it distinguishable from all of the other western species of the genus. The similarly grayish eastern species, *D. tennessa,* can be separated by the genitalial structures of both sexes. The latter has a large, distinct aedeagus in the male and its female has slender, longer, more acute cerci. Having examined the holotype female and several specimens from areas other than the type locality, I agree with Dr. Alexander that *D. quadrivittata* deserves full species status. The









FIGURES 109-112. *Dicranoptycha (D.) quadrivittata.* 109, male hypopygium, dorsal aspect. 110, left lateral aspect with external skeleton removed. 111, female hypopygium, left lateral aspect. 112, postero-ventral aspect.

cerci of the female holotype are quite different from those of *D. sobrina*. The shape of the cerci suggest a close relationship of this species to the western species group rather than to the eastern one. This is also true for the male genitalic structures, in which *D. quadrivittata* most closely resemble *melampygia* and *occidentalis* in having a small aedeagus and aedeagal process. It differs from these two species most noticeably by having two finger-like projections at the posterior end of the aedeagus.

GEOGRAPHIC AND SEASONAL DISTRIBUTION. *D. quadrivittata* is the most widespread species in the western species group; it ranges from southern British Columbia southeastward to southern Arizona and central Colorado (Map 14). It is the only species that inhabits the Rocky Mountains and associated ranges. It is unknown from the Pacific Coast States, but overlaps the range of some other western species in southern British Columbia. It is a summer species, collected during June, July and August.

Summary of distribution: Arizona - Apache Co., 25 June; Cochise Co., 8 July; Coconino Co., 7 July; Mohave Co., 18 July. British Columbia - Squamish, 5 August; Terrace, 4-7 August (not shown on map); Vancouver Island, 17 August. Colorado - Boulder Co., 25 August; Las Animas Co., 27 July. Idaho - Bingham Co., 27 July; Bonner Co., 3 July; Kootenai Co., 1 July. Montana - Lincoln Co., 31 July. New Mexico - Colfax Co., 27 June; Grant Co., 31 July; Santa Fe Co., 6 August; Torrance Co., 25 July; Valencia Co., 9 August. Utah - Duchesne Co., 1 July.

MAP 14. Known distribution of *Dicranoptycha quadrivittata* (circles), *D. linsdalei* (triangles) and *D. laevis* (square).

Dicranoptycha (Dicranoptycha) spinosissima Alexander

Dicranoptycha spinosissima Alexander, 1950, Pan-Pacific Entomol. 26: 83.

TYPES. Holotype, male, Hatchet Pass near Burney, Shasta County, California, 9 July 1947, C. P. Alexander. Allotype, Little Phillips Creek above Elgin, Blue Mountains, Umatilla County, Oregon, 2 July 1948, C. P. Alexander. One male paratype same data as allotype. All types are in the collection of C. P. Alexander, NMNH. The holotype and paratype are mounted on microscope slides.

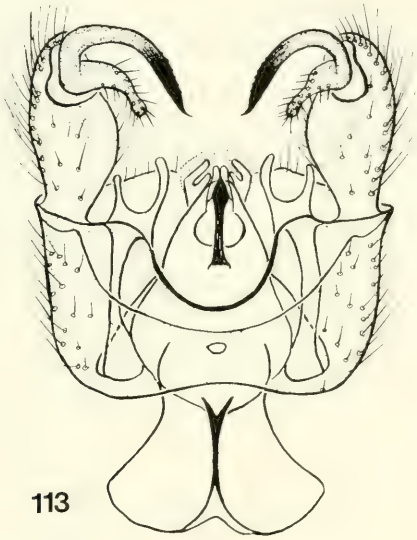
TAXONOMIC CHARACTERISTICS. Basic coloration grayish brown. Male body length 9-10 mm, wing 9.5 mm. Female body length 10 mm, wing 10.5 mm. *Head* gray, with one row of dark brown bristles around each eye. Rostrum brown, palpi black. Antennae with scape and pedicel yellow, flagellomeres black. Verticils about one and a half times length of their respective flagellomeres. *Thorax* mostly grayish brown with strong pruinosity on all surfaces. Prescutum darker with two pale faint longitudinal stripes. Pseudosutural foveae dark brown. Wings with brown tinge, strongly iridescent under light at certain angles, costal fringe short, vein 2A without setae. Legs with coxae brownish yellow, remainder of legs yellow, three outer tarsomeres brown. *Abdomen* brown. In male, posterior half of segment six and entire seventh and eighth segments forming broad, darkened subterminal ring. Male hypopygium (Fig. 113) brownish yellow. Dorsal dististyle long, slender, evenly curved, gradually narrowed to sharp apical spine; outer curvature denticulate on apical one-third. Ventral dististyle short, broad at base, narrowed at mid-length. Male genitalia (Fig. 114) with large, roughly oval vesica. Lateral process short, two-branched, extending to about one-third length of basistyle. Lateral apodeme with expanded lower part. Anterior apodemes nearly completely fused along mid-line to form single large structure about same size as vesica, broadly connected with vesica at base, slightly notched anteriorly with high median crest, greatest width about twice width at base. Ventral apodeme small, slender, keel-like. Aedeagus short, broad, with two small lobes on dorsal posterior margin; ventral posterior end produced on each side into two slender rods extending dorsad and covered by pale membrane densely set with small setae. Aedeagal

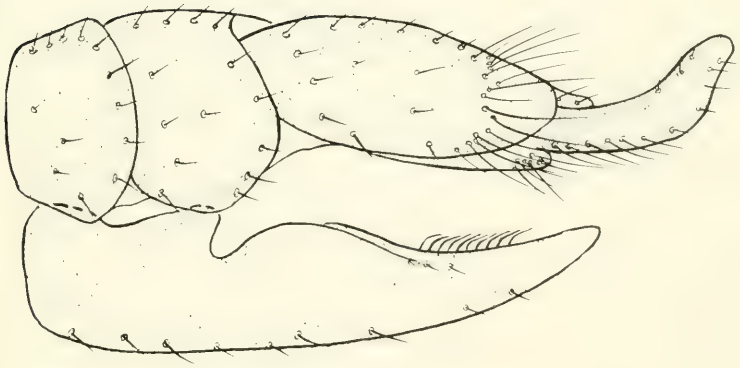
process lance-shaped, connected medially to top of aedeagus. Female genitalia (FIg. 115) of *melampygia* form. Cerci shorter than tenth segment, broad, slightly expanded near mid-length. Hypovalves reaching to about one-third length of cerci, ten setae on dorsal inner edge of each hypovalve. In postero-ventral aspect of external reproductive structures, ninth sternum and genital furca separated, receptacle for aedeagal process absent (Fig. 116).

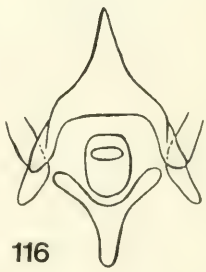
Comparative Notes. The long, slender dorsal dististyle, the two branched lateral process and the distinct spiny membrane around the apex of the aedeagus will at once separate males of *D. spinosissima* from those of all other species in the genus.

Geographic and Seasonal Distribution. *D. spinosissima* is known from southwestern British Columbia to northern California, including the northern Coast Ranges, Blue Mountains, Cascade Range and northern Sierra Nevada, but it has not been recorded from the Coast Ranges of California (Map 12). This species emerges in June and July in California and August in British Columbia.

Summary of distribution: British Colum-







Figures 113-116. *Dicranoptycha (D.) spinosissima.* 113, male hypopygium, dorsal aspect. 114, left lateral aspect with external skeleton removed. 115, female hypopygium, left lateral aspect. 116, postero-ventral aspect.

bia - Vancouver Island, 9-16 August. California - El Dorado Co., 6 June; Shasta Co., 7-9 July. Oregon - Umatilla Co., 2 July.

Dicranoptycha (Dicranoptycha) stenophallus Alexander

Dicranoptycha stenophallus Alexander, 1950, Pan-Pacific Ent. 26: 82.

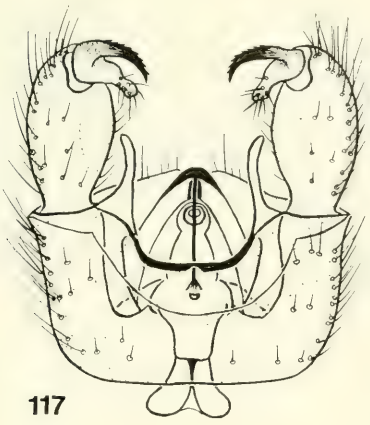
TYPES. Holotype, male, Madrona Camp, Siskiyou National Forest, Del Norte County, California, 1 August 1946, C. P. Alexander. Allotype, Little Phillips Creek, Blue Mountains, Umatilla County, Oregon, 2850 feet, 2 July 1948, C. P. Alexander. Paratypes, three males, same locality and date as allotype; eight males and five females from Langdon Lake, Blue Mountains, Umatilla County, Oregon, 4995 feet, 17 August 1948, C. P. Alexander. All types are in the collection of C. P. Alexander, NMNH. The holotype and three male paratypes are mounted on microscope slides.

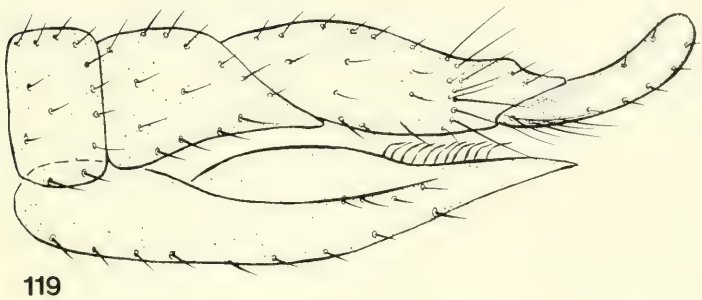
TAXONOMIC CHARACTERISTICS. Basic coloration ochraceous. Male body length 8-10 mm, wing 9-10 mm. Female body length 10-11 mm, wing 10.5-11 mm. *Head* gray, with one row of brown bristles around each eye. Rostrum brown, palpi dark brown. Antennae with yellow scape and pedicel, flagellomeres dark brown. Verticils short, about same length as their respective flagellomeres. *Thorax* ochraceous, with light gray pruinosity on pleura. Prescutum brown without longitudinal stripe. Pseudosutural foveae indistinct. Wings with brownish tinge, highly iridescent under light at certain angles, costal fringe short and dense. Legs with coxae yellow, pruinose, apical four tarsomeres brown, remainder of legs yellow. *Abdomen* brownish yellow. In male, segments seven and eight forming dark subterminal ring. Male hypopygium (Fig. 117) yellow. Dorsal dististyle slender and evenly curved to apical spine, outer curvature denticulate on apical two-thirds. Ventral dististyle broad at base, abruptly constricted at mid-length, and with obtuse apex. Male genitalia (Fig. 118) with vesica rounded posteriorly and narrowed anteriorly. Lateral process slender, reaching to about mid-length of basistyle. Lateral apodeme expanded equally on upper and lower parts. Anterior apodemes fused medially for nearly their full length, producing a single structure about two-thirds length of vesica, narrow at base and slightly notched anteriorly. Ventral apodeme small, keel-like. Aedeagus short, bent slightly ventrad. Aedeagal process with flat plate-like upper part, dark along rounded posterior margin, connected posteriorly to rod-like lower part, hanging downward behind aedeagus. Female genitalia (Fig. 119) of *melampygia* form. Cerci shorter than tenth segment, broad, with base slightly extended laterad. Long setae near posterior end of tenth tergum and basal margins. Hypovalves extending to slightly over one-third length of cerci. Eleven setae on inner dorsal edge of each hypovalve. Postero-ventral aspect of external reproductive structure shows aperture of bursa copulatrix wider at level of membrane and narrowed anterodorsally, with receptacle for aedeagal process situated beneath it (Fig. 120).

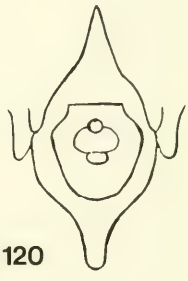
COMPARATIVE NOTES. D. stenophallus resembles *occitentalis* in body coloration. Males of these two species may be readily distinguished by the aedeagal process; the former has a distinctly rod-like lower part of the process hanging behind the aedeagus, such a process is absent in the latter. In genitalic structure, *D. stenophallus* closely resembles *nigrogenualis,* particularly in having this rod-like structure, but the larger body size and dark brown coloration of the latter species make these two readily distinguishable on sight. Alexander (1967) illustrated the male hypopygium of this species from the ventral aspect of a specimen mounted on a microscope slide; therefore, the rod-like lower part of the aedeagal process (phallosome, Alexander 1967) appears curved upward in the figure.

GEOGRAPHIC AND SEASONAL DISTRIBUTION. D. stenophallus is known from the Coast Ranges of southwestern British Columbia to the Coast Ranges of California, and from the Cascade Ranges to the Sierra Nevada (Map 15). *D. stenophallus* is a late summer species, as indicated by the collection data.

Summary of distribution: British Columbia - Vancouver Island, 25 August. California - Del Norte Co., 22 June, 1 August; El Dorado Co., 30 June; Humboldt Co., 7 August; Mono Co., 13 August; San Mateo Co., 8 August; Santa Cruz Co., 31 August; Shasta Co., 13 August; Siskiyou Co., 1 August. Oregon - Curry Co., 9 August; Lane Co., 15 August; Umatilla Co., 2 July, 17 August; Yamhill Co., 13-20 August. Washington - Grays Harbor Co., 20 August.







FIGURES 117-120. *Dicranoptycha (D.) stenophallus*. 117, male hypopygium, dorsal aspect. 118, left laterl aspect with external skeleton removed. 119, female hypopygium, left lateral aspect. 120, postero-ventral aspect.

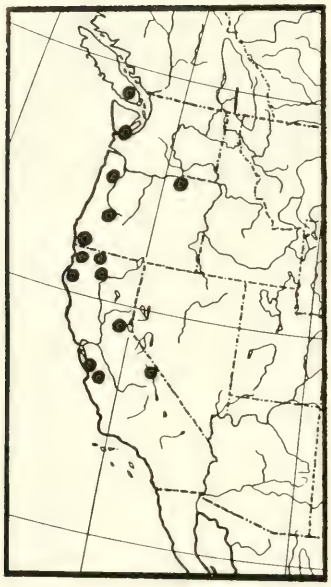
THE *LINSDALEI* GROUP

Dicranoptycha (Dicranoptycha) linsdalei Alexander

Dicranoptycha linsdalei Alexander, 1966, Trans. Amer. Entomol. Soc., 92: 110.

TYPES. Holotype, male, Hastings Natural History Reservation, Monterey County, California, 17 July 1948, J. Linsdale. Allotype, same data as holotype. Paratypes, 20 males and 18 females from type locality dated between 9 July and 20 July 1948. The holotype, allotype, five male and seven female paratypes are in CIS. Ten male and eight female paratypes are in CAS. Three male and two female paratypes are in the collection of C. P. Alexander, NMNH. Two males and one female are in the SEM. This list may not include all the paratypes that were designated originally; Alexander mentioned in his original description "paratypes widely distributed in various collections."

TAXONOMIC CHARACTERISTICS. General coloration reddish brown. Male body length 5-5.5 mm, wing 5.5 mm. Female body 5.5-6 mm, wing 6 mm. *Head* brownish gray, with one row of brown bristles around each eye. Rostrum brown, palpi black. Antennae brown throughout. Verticils about same length as their respective flagellomeres. *Thorax* reddish brown with gray pruinosity on all surfaces. Prescutum without longitudinal stripe. Pseudosutural foveae brown. Wings with yellowish tinge, costal fringe short and dense, vein 2A without setae. Legs with coxae brownish yellow, slightly pruinose basally, femora, tibiae and basitarsi yellow, with four outer tarsomeres brown. *Abdomen* with brownish yellow terga and yellow sterna. In male, segment seven dark brown, forming subterminal ring. Male hypopygium (Fig. 121) brownish yellow, dorsal dististyle denticulate on outer two-thirds of outer curvature. Ventral dististyle slightly larger, broad at base narrowed to evenly rounded tip. Male genitalia (Fig. 122) with vesica small on the dorsal aspect, with a



MAP 15. Known distribution of *Dicranoptycha stenophallus.*

large ventral part. Lateral process short, extending to about one-third length of basistyle. Lateral apodeme broad in lower part. Anterior apodemes fused along median line forming, single structure, larger than vesica. Ventral apodeme large, keel-like. Aedeagus small, inconspicuous. Aedeagal process with wide flat base and small rod-like structure posteriorly bent ventrad behind aedeagus. Female genitalia (Fig. 123) with very short cerci, about one-third length of tenth segment. Cerci widest near mid-length, with subacute tip. Long setae near posterior end of tenth segment. Hypovalve extending to slightly before base of cercus with long setae at base and along outer ventral surface. No setae on inner dorsal edges of hypovalves, hypovalve with blunt posterior end. Postero-ventral aspect of external reproductive structure as in Fig. 124.

COMPARATIVE NOTES. D. linsdalei is the smallest representative of the genus in North America. The other two small species, *D. laevis* in the West and *minima* in the East, can be separated from *linsdalei;* by having smooth dorsal dististyles, which are denticulate in *linsdalei.* Females of this species can be easily recognized by their small cerci.

GEOGRAPHIC AND SEASONAL DISTRIBUTION. D. linsdalei is so far known from only three localities in California (May 14). The type locality, in Monterey County, and the other two, Santa Barbara County and Ventura County, suggest a distribution confined to the Coast Ranges of central California. The collection dates indicate it is a late spring to early summer species.

Summary of distribution: California - Monterey Co., 5 June to 19 July; Santa Barbara Co., 7 July; Ventura Co., 10 July.

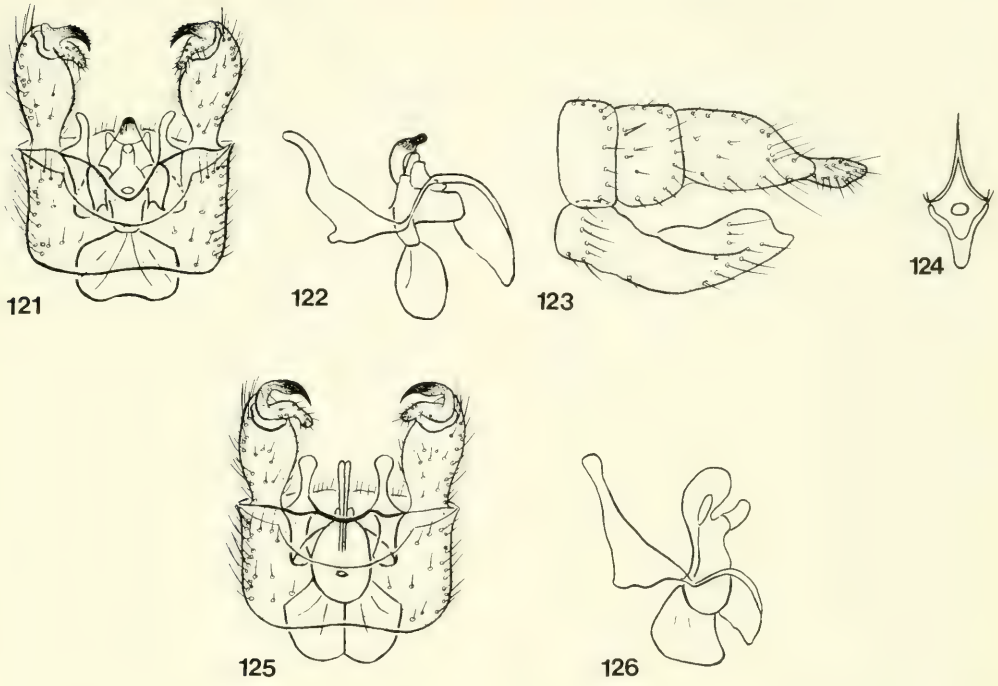
THE UNGROUPED SPECIES

Dicranoptycha (Dicranoptycha) laevis Alexander

Dicranoptycha laevis Alexander, 1947, Bull. Brooklyn Entomol. Soc. 42: 131.

TYPES. Holotype, male, Palomar Mountain, altitude 4700 feet, San Diego County, California, 12 July 1946, C. P. Alexander. Allotype, and three male paratypes same data as holotype. The holotype, allotype, and paratypes are in the collection of C. P. Alexander, NMNH. The allotype could not be located at the time I examined the type series.

TAXONOMIC CHARACTERISTICS. General coloration light brown. Male body length 6-6.5 mm, wing 6.5 mm. Female body length 6.5-7 mm, wing 7 mm. *Head* ash gray with one row of brown bristles around each eye. Rostrum light brown, palpi dark brown. Antennal scape dark brown, pedicel brownish yellow, flagellomeres brown. Verticils about one and a half times length of their respective flagellomeres. *Thorax* light brown. Prescutum darker with two obscure brown stripes. Pseudosutural foveae indistinct. Wings with grayish tinge, costal fringe short, vein 2A without setae. Legs with coxae and trochanters yellow, remainder of legs and proximal four tarsomeres light brown, apical tarsomeres brown. *Abdomen* grayish brown. Male with darkened subterminal ring on seventh segment. Male hypopygium (Fig. 125) with dorsal dististyle narrowed at base, expanded at mid-length, then narrowed into terminal spine. Ventral dististyle slightly longer than dorsal one, with rounded tip. Male genitalia (Fig. 126) with rounded vesica. Lateral process extending to about mid-length of basistyle. Lateral apodeme broad in upper part. Wide anterior apodemes broadly attached to vesica at base, fused medially except for slight notch at anterior margin. Ventral apodeme keel-like, well developed. Aedeagus inconspicuous in both dorsal and lateral aspects.



FIGURES 121-124. *Dicranoptycha (D.) linsdalei.* 121, male hypopygium, dorsal aspect. 122, left lateral aspect with external yskeleton removed. 123, female hypopygium, left lateral aspect. 124, posteroventral aspect.

FIGURES 125-126. *Dicranoptycha (D.) laevis.* 125, male hypopygium, dorsal aspect. 126, left lateral aspect with external skeleton removed.

Aedeagal process with two closely appressed blades, each compressed, rounded posteriorly, downwardly recurved to fuse with dorsum of aedeagus. Since female specimens of this species could not be obtained, details of the female genitalic structures are omitted.

COMPARATIVE NOTES. The male of *D. laevis* is readily distinguished by its unique aedeagal process, which consists of two flattened plates that lie side by side. The smooth dorsal dististyle separates this species from the similar *D. linsdalei,* which has denticulate dorsal dististyles. Although females of this species are unknown to me, they will probably closely resemble those of *D. linsdalei,* to judge from the similarity of the males.

GEOGRAPHIC AND SEASONAL DISTRIBUTION. *D. laevis* is so far known only from the type locality on Palomar Mountain, San Diego County, California (Map 14). The type series was collected in mid July.

DISCUSSION

SPECIES DELIMITATION. All species of *Dicranoptycha* exhibit moderate variation in size and color, but I do not consider these variations to have taxonomic significance in the genus. Byers (1961: 704) pointed out that size variation among flies of the same sex may result from variation in larval nutrition. Color variation may be correlated with geographic distribution, or in specimens from one locality it may result from differences in age. Most species of *Dicranoptycha* are morphologically well defined; interspecific variation in the genitalia is usually distinct, and species can to some extent be recognized by genitalial characters alone. However, in cases where the similarity of genitalia precludes their use in species recognition, other factors such as geographical distribution, were taken into account. *D. sobrina* and *tennessa,* for example, are sympatric over a large

area; they are considered full species in spite of close morphological resemblance. *D. nigripes* and *tigrina,* although similar, are morphologically distinct and allopatric. Because there is no indication of intergrades between them and their zone of contact (if any exists) is unclear, they are treated as full species.

SYSTEMATIC RELATIONSHIPS. Of the six genera within the current limits of the tribe Limoniini (Alexander, 1942), *Dicranoptycha* is morphologically and biologically more distinct from the other five than they are among themselves. On the basis of characters of the immature stages, *Dicranoptycha* has been considered as having closest affinities with *Antocha* and *Rhamphidia* by Alexander (1919b), and with Atarba by Rogers (1927). Of these, only the first is in the Limoniini. Unlike most genera in the tribe Limoniini which spend their immature stages in semi-aquatic situations, the larvae of *Dicranoptycha* live in the upper layer of soil under leaf mold. The origin of the shift to this much drier larval habitat forms an interesting subject for speculation.

It has been assumed that crane flies as a group arose from ancestors whose larvae, though terrestrial, lived in damp moss. It is believed that they evolved from this semi-aquatic form to either an aquatic (*Antocha*) or terrestrial form. The wholly terrestrial habitat of *Dicranoptycha* is probably a specialization. Presumably its larvae successfully invaded the terrestrial habitat early during the evolution of the genus and thereafter *Dicranoptycha* has become increasingly terrestrial. The only other woodland tipulid genus in which the early stages are spent in relatively dry soil is *Cladura* of the tribe Eriopterini.

Several unique characters found in the larvae of *Dicranoptycha* probably are adaptations for terrestrial life. The larvae have apparently functional spiracles on abdominal segments 1-7, which are unknown in other crane flies. The body of the larva is probably covered by a secretion, protecting it from direct contact with earth particles. And the mature larva constructs an earthen pupal cell that protects it from dehydration.

PHYLOGENY AND ZOOGEOGRAPHY. Although the world-wide phylogeny of the genus *Dicranoptycha* is beyond the scope of the present study, a few tentative points can be presented on phylogenetic relationships among North America *Dicranoptycha.*

Two characters found on females were used to delimit species groups. The first is the cerci, their shapes and their lengths relative to the length of the tenth segment. The other character is the number of setae on the tenth abdominal tergum. The resulting *germana, melampygia,* and *linsdalei* species groups have both morphological and geographical bases.

The *germana* group consists of all fifteen eastern species. Females of this group have long, slender cerci and about a dozen setae near the posterior end of the tenth tergum. I consider this form of cerci primitive because it is the most common and is widely shared by crane flies of other genera (although its being common does not necessarily mean it is primitive). The *melampygia* group consists of six of the seven western species. Females of this group have broad, spatulate cerci, generally shorter than the tenth tergum, and more than a score of long setae near the posterior end of the tenth tergum and along the slightly flared cercal bases. I consider this apomorphic; it resembles that of females of the Palearctic subgenus *Ulugbekia.* The *linsdalei* group contains only *D. linsdalei* from the west coast. The female has short cerci, fused in their basal halves, and has about a dozen setae near the posterior end of the tenth tergum. I consider this also as a derived form, compared to the *germana* group. Probably all three groups differentiated and evolved in the Old World before they invaded North America, as discussed in the following section.

The widespread subgenus *Dicranoptycha* s.str. is represented by 23 species in North America, 22 in Madagascar, 17 in Asia, eight in Africa, five in Europe, three in Central America and one in India. There seem to be two species-rich centers for the genus *Dicranoptycha,* one in Madagascar, the other in the United States. Because of the abundance and diversity of *Dicranoptycha* in the Holarctic and Ethiopian re-

gions, and its complete absence in South America and Australia, it seems likely that *Dicranoptycha* arose somewhere in the Old World. Probably from Eurasia, one branch of the genus invaded Africa, and speciated extensively in Madagascar; another spread through southern Asia. A third branch, or probably three branches, migrated across the Bering land bridge into North America. The discovery of *D. electrina* Alexander (1931b) in the late Eocene Baltic Amber is of exceptional interest, for it is nearly identical to some modern forms. An existing species that has a distinct wing pattern similar to that of *D. electrina* is *D. keiserae* from Madagascar. This fossil record also shows that *Dicranoptycha* has been differentiated and separated from the rest of the Limoniini since the early Tertiary Period.

Two geographic groups of species of *Dicranoptycha* can be defined in North America. The eastern *germana* group occurs mainly in the eastern forest region and as far west as the mid-western plains states. This group shows a decline in numbers of species from Virginia to Kansas and from Georgia to Canada. Among this group, *Dicranoptycha germana* has the most northern distribution, the northern limit of which appears to be in southern Canada. *D. sobrina* and *winnemana* have widespread distributions in the eastern states, reaching the plains states to the west and extending southward into central Florida. *D. elsa, septemtrionis* and *tigrina* range from the northern Appalachians westward to Kansas. *D. minima* and *pallida* are restricted to the mid-western plains states. The remaining species of this group have an eastern-southern distributional pattern, especially in the lower valleys and foothills of the Appalachians. The western geographic group, which includes both the *melampygia* and *linsdalei* species groups, is found from the Rocky Mountains to the Pacific Coast. The *melampygia* group occupies mainly the Coast Ranges and west side of the Sierra Nevada, with its center in western California. *D. quadrivittata* is the only species of this group that has an inland distribution; it is widespread along the Rocky Mountains and into the Uinta Mountains, the Colorado Plateau, and the Pacific Northwest. The *linsdalei* group, containing *D. linsdalei* and probably *laevis,* is known only from central and southern California.

That at least two, possibly four, independent invasions from Eurasia have occurred is suggested by the present *Dicranoptycha* fauna in North America. The *germana* group, structurally the most primitive, probably entered North America earlier than the *melampygia- linsdalei* or western group. This conclusion is based on the fact that the *germana* group has numerous allies in the Old World, and on the primitive or unspecialized structure of the female cerci. The ancestors of the germana group probably reached America in the Bering Strait region during the late Tertiary, when that region had a climate much warmer than it is now. Given the Eocene fossil in Europe, another possibility is that the *germana* group came across the North Atlantic when that ocean was much narrower than it now is. The group also probably ranged more widely than it does now. Pleistocene climate must have played an important role in their present distribution. The *germana* group may have taken refuge in the southern Appalachian Mountains during the last continental glaciation, with most of them migrating northward and westward after the ice retreated.

The western or *melampygia* group probably entered North America at a later date. This group is related to a similar palearctic group found in Japan, Korea and northern China. Morphologically it is most like the subgenus *Ulugbekia,* which probably evolved in Central Asia. The recent arrival of the *melampygia* group in North America is also indicated by the smaller number of species. The arrival of the *melampygia* group in North American probably resulted in the exclusion of the *germana* group from a previous western part of its range.

The structure of the female cerci of *D. linsdalei* is similar to that of several species endemic to Madagascar, suggesting that *D. linsdalei* or some ancestor of it entered North American before the *melampygia* group and is now relictual in North America. Like the *germana* group, it may have been excluded from a wider western range by the *melampygia* group. On the other

hand, it may have a North American origin, the similarity between it and the species in Madagascar being due to parallelism or convergence.

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THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN

A Revision of *Venturia* North of Central America (Hymenoptera: Ichneumonidae)

By
D. B. Wahl

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THE UNIVERSITY OF KANSAS
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A Revision of *Venturia* North of Central America (Hymenoptera: Ichneumonidae)[1]

D. B. Wahl[2]

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Abstract

The porizontine genus *Venturia* is revised for America north of Central America. Fifty-two species were found within this area, forty-one of which were previously undescribed. Keys, descriptions and illustrations are given for all species. A phylogenetic analysis using the methods of Hennig was performed. Difficulties involving identification of the outgroup and the apparent presence of extensive homoplasy led to the discovery of only three monophyletic groups containing a total of sixteen species. The interrelationships of the remaining species, and of the three monophyletic groups, remain unresolved.

Introduction

Venturia is a large genus of porizontine ichneumonids, distributed worldwide but with the New World being one of the areas of greatest diversity. This study deals with the 52 species found in America north of Central America. They are chiefly parasitoids of microlepidoptera that feed in concealed situations (leaf rolls, buds, and cases) but some are known or inferred to parasitize exposed larvae. Mixed mesophytic environments harbor the greatest number of species, although the genus is

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often found in areas that are more open and drier than is usual for porizontines. As most ichneumonid collecting has concentrated on fairly moist environments, this tendency toward drier areas is perhaps partly responsible for the relative scarcity of *Venturia* in collections. Excluding the common introduced granary species *Venturia canescens*, only about 1400 specimens were available for study.

Although relationships within the group of genera to which *Venturia* belongs are not resolved, *Venturia* is monophyletic. Attempts to elucidate the phylogeny of the Nearctic fauna have not been very successful, due to weak characters and a high degree of homoplasy. These factors, plus the relatively small number of specimens, preclude any meaningful biogeographical analysis.

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I thank Dr. C.D. Michener of the University of Kansas for his advice, encouragement, and criticism during the course of this study. His unflagging enthusiasm and eye for detail were greatly appreciated. Drs. George W. Byers and E.O. Wiley, also of the University of Kansas, and two anonymous reviewers, have carefully read the manuscript and their attentions are gratefully acknowledged. A special note of thanks is due Drs. Henry and Marjorie Townes of the American Entomological Institute, Gainesville, Florida, for both the loan of material (comprising the majority of specimens used) and for their gracious hospitality during my visits to their collection. Henry Townes' willingness to share his knowledge of ichneumonid systematics with a novice will always be remembered. Although a number of my fellow graduate students at the University of Kansas have helped in various ways, I would like to express my thanks to two in particular. Robert W. Brooks' free sharing of his electron microscopy and computer skills played an important role in the completion of my study. James Pakaluk has spent long hours discussing various aspects of this study. Dr. Oliver C. Phillips of the Department of Classics, University of Kansas, checked the linguistic correctness of my species names and offered improvements in several instances. Finally, but only in printed position, are my parents, Walter and Louise Wahl.

Materials, Methods & Terminology

Specimens examined for this study were borrowed from or deposited in the following collections and I am indebted to the curators listed below. Acronyms used are either from Arnett & Samuelson (1969) or consistent with their style:

Academy of Natural Sciences of Philadelphia (ANSP): Philadelphia, Pennsylvania (D. Azuma).
American Museum of Natural History (AMNH): New York, New York (M. Favreau).
British Museum (Natural History) (BMNH): London (M. Fitton).
California Academy of Sciences (CASC): San Francisco (P.A. Arnaud, Jr.).
Canadian National Collections (CNCI): Ottawa, Ontario (J.R. Barron).
Cornell University (CUIC): Ithaca, New York (L.L. Pechuman).
Clement E. Dasch Collection (CEDC): New Concord, Ohio.
Florida State Collection of Arthropods (FSCA): Gainesville (H.V. Weems).
Illinois Natural History Survey (INHS): Urbana (W.E. LaBerge).
Los Angeles County Museum of Natural History (LACM): Los Angeles, California (R.R. Snelling).
Louisiana State University (LSUC): Baton Rouge (J.B. Chapin).
Michigan State University (MSUC): East Lansing (R.L. Fischer).
Museum of Comparative Zoology (MCZC): Harvard University, Cambridge, Massachusetts (R.J. McGinley).
National Museum of Natural History (USNM): Washington, D.C. (R.W. Carlson)
Ohio State University (OSUC): Columbus (C.A. Triplehorn).
Oregon State University (OSUO): Corvallis (J.D. Lattin).
John M. Schmid Collection (JMSC): Ft. Collins, Colorado.
Texas A. & M. University (TAMU): College Station (S.J. Merrit).
Henry and Marjorie Townes Collection (HMTC): Gainesville, Florida.
University of California, Berkeley (CISC): (L.E. Caltagirone).
University of California, Davis (UCDC): (R.O. Schuster).
University of California, Riverside (UCRC): (J.C. Hall).

University of Georgia (UGCA): Athens (C.C. Smith).
University of Kansas (SEMC): Lawrence (G.W. Byers).
University of Massachusetts (UMEC): Amherst (T.M. Peters).
University of Wisconsin (UWEC): Madison (S. Krauth).
David B. Wahl Collection (DBWC).
Washington State University (WSUC): Pullman (R.S. Zack).

The morphological terminology is mostly that of Townes (1969). I have used the terminology of Bohart & Menke (1976) and Michener (1944) for certain structures in order to help initiate a common terminology within the Hymenoptera. *Gena* is used in place of "temple", *malar space* for "cheek", *supraclypeal area* for "face", *hypoepimeron* for "speculum", *subalar ridge* for "subtegular ridge", and *scrobe* for "mesopleural fovea". The mesopleural depression immediately anterior and ventral to the hypoepimeron is referred to as the *scrobal groove* (fig. 2a). *Central area* is used for the combined areola-petiolar area of the propodeum. *Mesosoma* and *metasoma* are used to refer to the apparent thorax and abdomen, respectively. *First metasomal segment* applies to the second true abdominal segment. Reference to the orientation of the various parts of the body follows Townes (1969) in that the legs are considered to be stretched out horizontally at right angles to the body.

Coloration of the body parts, especially that of the metasoma, can be affected by the amount of oils on the specimen (from internal or other sources); oily specimens are generally darker and often exhibit irregular fuscous areas on the normally brownish red portions of the metasoma. Reference to metasomal color in the descriptions refers only to the tergites and first sternite.

These abbreviations are used in the text: *OOD* for "ocellocular distance"; *OD* for "ocellar diameter"; *FMS* for "first metasomal segment"; *T1, T2,* etc., for the first metasomal tergum and following terga and *S1, S2,* etc., for the first metasomal sternum and following sterna. The "ocellar diameter" refers to the greatest transverse measurement of either of the lateral ocelli.

When the lengths of the body, wing, and ovipositor are given, the values in parentheses are those of the holotype.

SEM photographs were made with a Phillips 501 Scanning Electron Microscope. Specimens were sputter-coated with a 200 Å gold-palladium coating.

Male genitalia were prepared in the following manner. After a specimen was placed in a humidifying chamber overnight, the terminal segments of the metasoma were clipped off and soaked in room-temperature 10% KOH for approximately 12 hours. The genitalia were then disassociated from the remaining parts of the metasoma, briefly placed in dilute acetic acid, rinsed in distilled water, and transferred to glycerine in a storage container. The right gonoforceps and ninth sternum were then placed in glycerine jelly on a microscope slide under a cover slip and drawn. This procedure necessitates some distortion of the normally curved gonoforceps, but all specimens were uniformly prepared in this manner and allows accurate comparison of the apical notch of the gonoforceps. The gonoforceps and ninth sternum were then stored, along with the remaining parts of the genitalia, in glycerine in a genitalia vial pinned with the specimen.

A warning should be made at this time. Although I strove to make all measurements and descriptions as explicit as possible by the use of drawings and photographs, the user unfamiliar with porizontines should use discretion. The characters are subtle in many cases, and such things as surface sculpture or degree of granulation could be traps for the unwary. About 2000 specimens were examined, 640 of which belonged to *V. canescens*. When the more abundant species (*sokanakiakorum, micraulax, nigriscapus, erythropus, marjoriella,* etc.) are taken into consideration, it is obvious that most of the new species are based on relatively few specimens. I have tried to indicate intraspecific variation, but it remains a potential problem as regards recognition of many of the species. In all likelihood, reliable determinations can be made only with experience and comparison with determined specimens of a number of species, as well as consideration of the characters given in the descriptions.

I have used females as the basis for recognition of new species. Not only are they more numerous in collections than males, but they also provide more characters. Although I have examined males that undoubtedly belong to undescribed species, I have chosen not to describe them until they can be associated with females. The one exception is the previously described *leptogaster* Cameron, known only from male specimens; I have redescribed it. Except for this species, the diagnoses refer only to the female sex.

The species descriptions are divided into 13 numbered sections for ease of reference. The following are explanations of measurements and characters as needed.

1. The malar space is measured from the upper articulation of the mandible to the lower margin of the compound eye.

3. The head in frontal view is roughly triangular (fig. 20e), but is sometimes more rounded, as in figs. 19a-k. The ocellar diameter (OD) is measured across the transverse axis of the lateral ocellus at its widest point and in a plane parallel to the sloping surface of the ocellar triangle. The compound eyes are usually strongly bulging but are sometimes as in fig. 20m.

4. Genal width is measured in dorsal view as in fig. 3s, the value being a/b. Males almost always have the gena wider than in the females and usually with a value of 0.5.

5. The profile of the mesosoma and its major regions can be quite diagnostic for a species. The mesonotum can be strongly anteriorly produced (fig. 22b), weakly produced (fig. 24l), or of an intermediate nature. The same goes for the degree of elongation of the mesopleurum with the elongate condition as in fig. 24i and the weakly elongate as in fig. 24m. The subalar ridge is usually weakly rugosopunctate but is occasionally punctate and smooth. Some species are hard to place with respect to this character; if the punctures are distorted, I call the condition weakly rugosopunctate.

6. The shape of the lateral area of the pronotum is variable and useful, as is the strength of the rugae that parallel the collar. The condition of the surface of the upper corner of the lateral area can be: a) moderately to strongly granulate with few or no punctures (fig. 1a); b) predominantly granulate with more punctures concentrated along its margin; c) granulate with numerous punctures throughout, giving a shagreened appearence (fig. 1b-c); d) rugosopunctate with the punctures distorted (at least to some degree) by the rugae (fig. 1e-f), usually on a smooth surface but occasionally with some granulation on the rugae; e) numerous strong punctures on a smooth surface (fig. 1d). The collar is usually weakly rugosopunctate but occasionally is punctate on a smooth surface.

7. Mesopleural punctation is measured in the area immediately below the hypoepimeron. The sculpture both here and on the upper corner of the pronotum is of the type referred to by Harris (1979) as granulate. This varies in strength from strongly granulate (appearing pebbled, fig. 2b-c) to weak (with only shallow grooves present) to absent (appearing smooth and polished at high [80x] magnification). Whenever surfaces are referred to as "smooth", this refers to a complete lack of granulation. Fig. 2d is intermediate between strong and weak and is deemed moderate. Most species have the punctures deep and ranging in diameter from 0.1-0.2 OD. Such punctation is considered to be moderate. Coarse punctation refers to shallow punctures 0.2-0.3 OD. The punctures along the dorsal and posterior margins of the hypoepimeron are diagnostic but subtle. They can be: a) absent; b) present but sparse and/or weak with only a few scattered punctures; c) strong and present along the dorsal and upper 0.5 of the posterior margin; d) strong and present along all of the margins. Fig. 2a shows the transverse rugae of the scrobal groove.

8. The areolar length is measured from the base to the juncture with the petiolar area (the latter usually well-marked by a constriction, although this is sometimes obscure) and the areolar width at its juncture with the petiolar area. The resulting value of the length divided by the width is used to determine whether the areola is elongate (2.0 or greater), somewhat elongate (1.1-1.6), or as long as wide. The constriction of the juncture of the areola-petiolar area is considered either strong (fig. 16f), moderate (fig. 16l), or weak (fig. 16e). These categories are sometimes hazy. The width and length of the propodeal neck are measured as in fig. 3r. In males, the carinae and general surface sculpture of the propodeum are usually more pronounced and the central area is usually narrower than in the female. While there are differences in the outlines of the propodea of different species, the problems of drawing each specimen in the same orientation and recognizing undefined edges (due to the sloping sides) should be kept in mind.

9. The width of the hind femur is measured at the mid-length. The longer of the two hind tibial spurs is used in the comparison of the hind tibial spur and the hind basitarsus.

11. The first metasomal segment (FMS) has a variety of shapes, ranging from relatively elongate with the postpetiole high (fig. 13u) to stout (fig. 13p). Although the endpoints are distinct, the intermediates can be hard to characterize. The length of the petiole is measured from its articulation with the propodeum to the spiracle; the postpetiole is measured from the spiracle to the apex of T1. Different species may have similar ratios of petiole/postpetiole lengths but different appearances due to the stoutness of the petiole and height of the postpetiole.

12. The degree of lateral compression of the metasoma can be weak (fig. 3i), moderate (fig. 3j), or strong (fig. 3k). Since the metasoma is occasionally distorted, a series of specimens of a species is helpful in making this interpretation.

In species which have T2 of the females

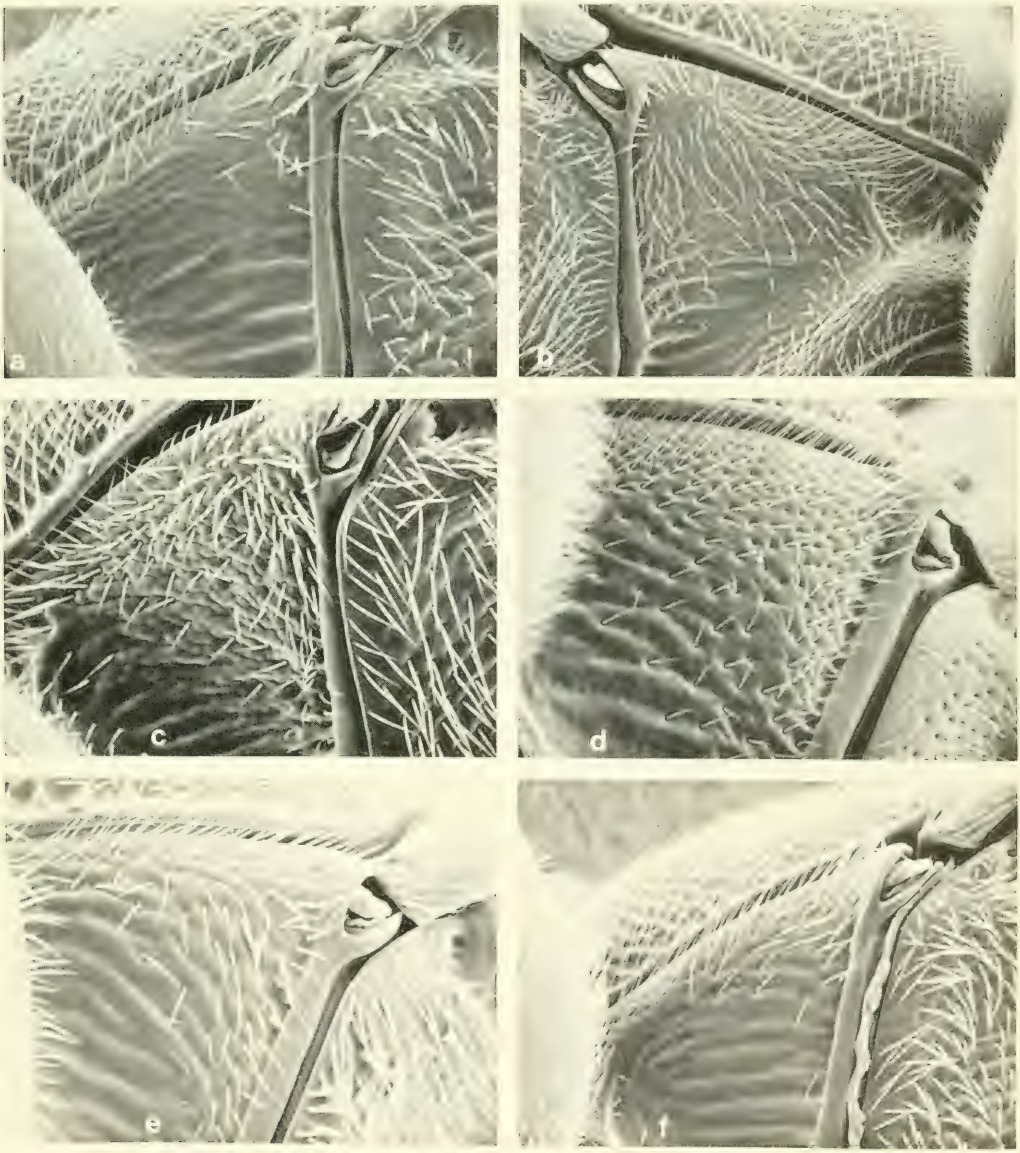

FIGURE 1. Upper corner of lateral area of pronotum. A. *Venturia eremna* Wahl, B. *V. erythropus* (Ash.), C. *V. micraulax* Wahl, D. *V. scitula* Wahl, E. *V. canescens* (Grav.), F. *V. sokanakiakorum* (Vier.).

shorter than is normal for the genus (such as *V. hadra, finlaysoni,* etc.), the males have the segment longer and comparable to those of males of more typical species.

13. Degree of curvature of the ovipositor is referred to as straight, weak (fig. 3a-c), moderate (fig. 3d-f), or strong (fig. 3g-h). The remark about distortion made in section 12 (above) applies here. The length, if its base is hidden by enveloping terga, is estimated relative to the position of the apices of the valvifers and is believed to be accurate. The ovipositor apex is usually as in fig. 4e with deviations from that state noted under the individual species. Normally weakly laterally compressed, the apical half of the ovipositor is strongly compressed in *V. gaesata* and *V. platyura.*

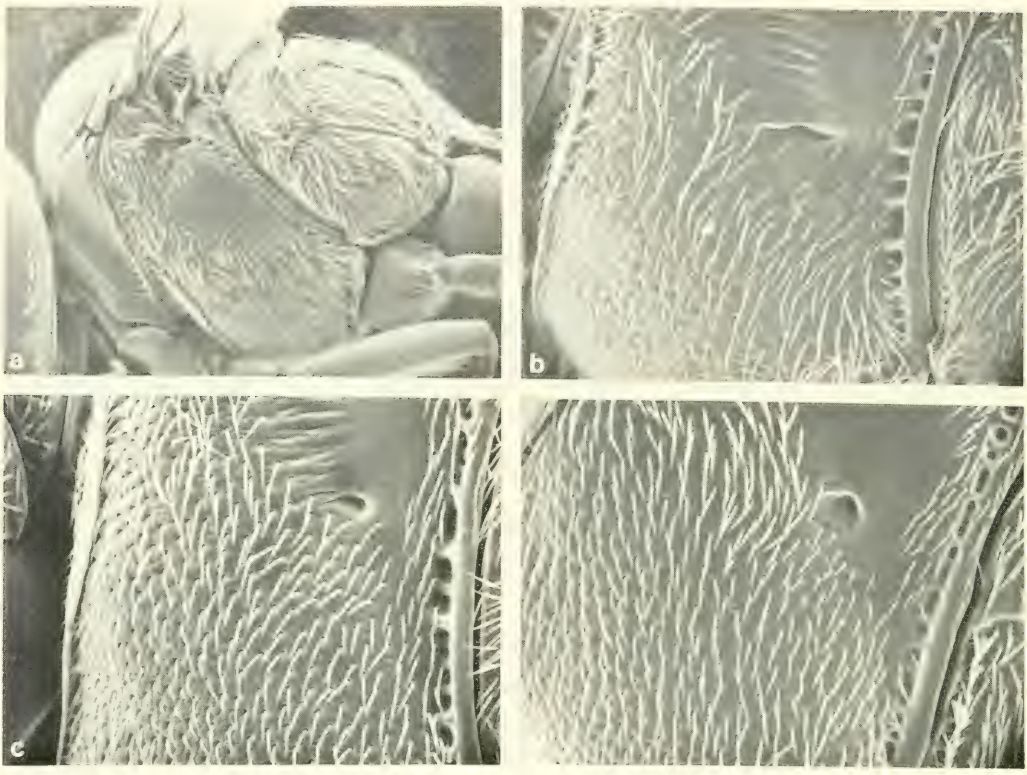

FIGURE 2. **A,** Lateral aspect of mesosoma of *Venturia sokanakiakorum* (Vier.). **B-D,** Ventral half of mesopleurum. B. *V. eremna* Wahl, C. *V. micraulax* Wahl, D. *V. canescens* (Grav.).

TAXONOMIC HISTORY

Genus *Venturia* Schrottky

Idechthis Foerster, 1868. Verh. Naturh. Ver. Rheinlande 25: 154. Name preocc. by Huebner, 1821. Type species: (*Idechthis oahuensis* Ashmead) = *Campoplex canescens* Gravenhorst; first included by Ashmead (1901) and then monobasic.

Venturia Schrottky, 1902. An. Mus. Nac. Buenos Aires 8: 102. Type species: *Venturia argentina* Schrottky. Monobasic. Synonymized by Townes & Townes, 1966.

Devorgilla Cameron, 1907. Tijdschr. v. Entomol. 50: 51. Type species: *Devorgilla dilatata* Cameron. Original designation. Synonymized by Townes and Townes, 1966.

Balcarcia Brèthes. 1922. An. Soc. Cient. Argentina 93: 133. Type species: *Balcarcia bergi* Brèthes. Monobasic. Synonymized by Townes & Townes, 1966.

Notamorphota Blanchard, 1947 (1946). Acta Zool. Lilloana 3: 292. Type species: *Notamorphota timocraticae* Blanchard. Original designation. Synonymized by Townes & Townes, 1966.

Exidechthis Walkley, 1958. *In* Krombein *et al.*, United States Dept. Agric. Monog. 2, supp. 1, p. 59. New name for *Idechthis* Foerster.

Slenda Gauld, 1984. *An Introduction to the Ichneumonidae of Australia,* p. 282. Type species: *Slenda ocypeta* Gauld. Original designation. New synonym.

Venturia may be readily distinguished from other porizontines by the following: eye not emarginate opposite antennal socket; gena relatively wide, not receding immediately behind eye; occipital carina joining hypostomal carina above base of mandible; mesopleural sulcus impressed as sharp groove; propodeum without median longitudinal depression, its apex usually reaching at least to middle of hind coxa; second lateral area almost always defined by carinae; petiole cylindrical, suture separating T1 from S1 in middle of lateral aspect and S1 of uniform depth throughout

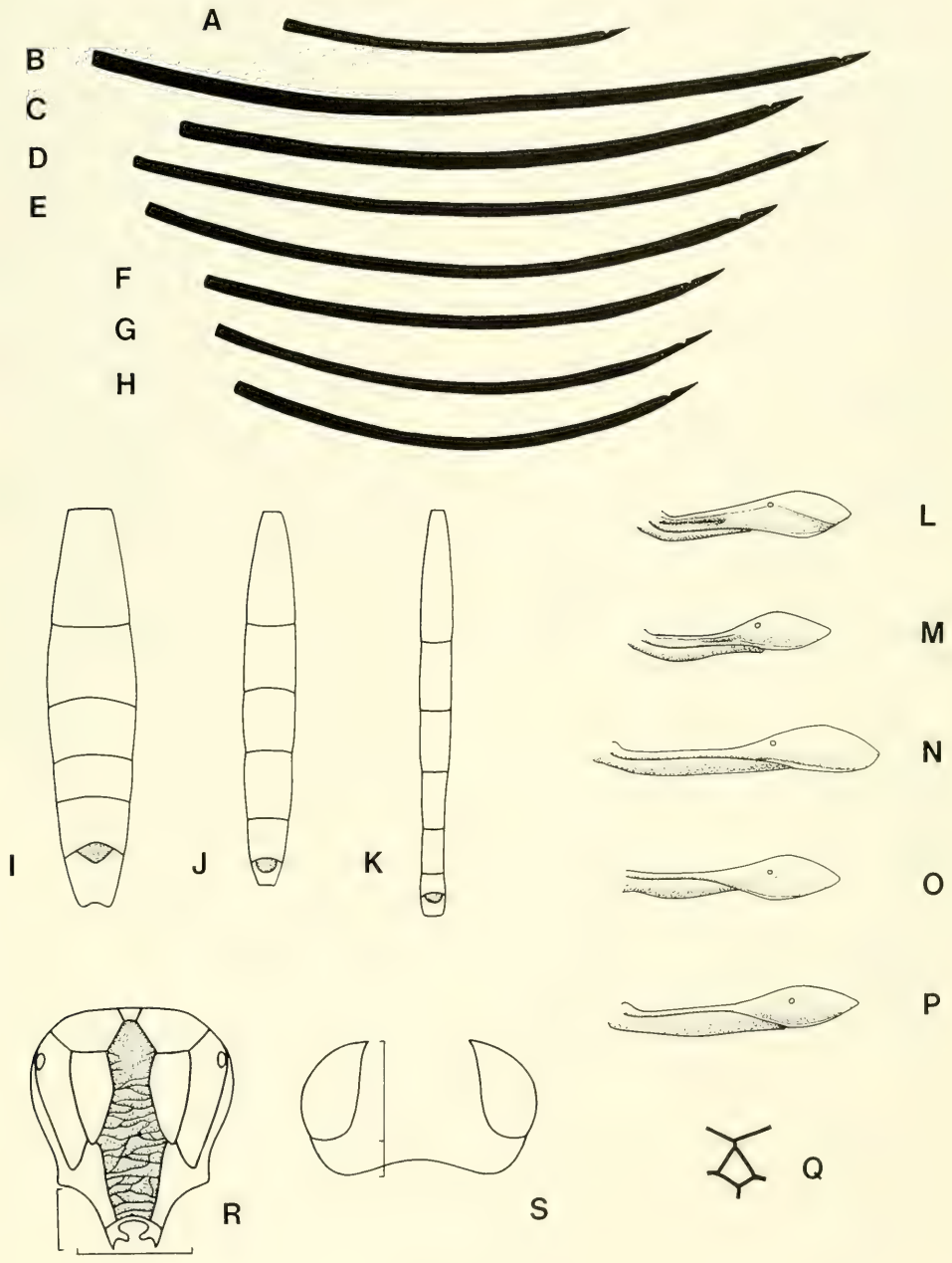

FIGURE 3. **A-H,** Lateral outline of ovipositor. A. *Venturia sokanakiakorum* (Vier.), B. *V. daschi* Wahl, C. *V. platyura* Wahl, D. *V. canescens* (Grav.), E. *V. portalensis* Wahl, F. *V. dreisbachi* Wahl, G. *V. eremna* Wahl, H. *V. gaesata* Wahl. **I-K,** Dorsal aspect of T2-7. I. *V. erythrogaster* Wahl, J. *V. portalensis* Wahl, K. *V. nigriscapus* (Vier.). **L-P,** Lateral aspect of first metasomal segment. L. *Campoplex* sp., M. *Sinophorus* sp., N. *V. nigriscapus* (Vier.), O. *Casinaria eupitheciae* (Vier.), P. *Casinaria* sp. **Q.** Areolet of *V. punctata* Wahl. **R.** Dorsal aspect of propodeum of *V. capulata* Wahl. S. Dorsal aspect of head *V. anchisteus* Wahl.

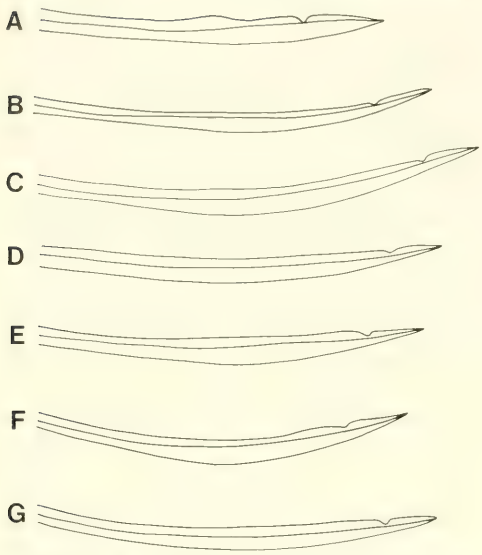

FIGURE 4. A-G, Lateral aspect of ovipositor apex. A. *Venturia dreisbachi* Wahl, B. *V. longicuspis* Wahl, C. *V. taneces* Wahl, D. *V. gaesata* Wahl, E. *V. eremna* Wahl, F. *V. licina* Wahl, G. *V. durangensis* Wahl.

its length; T1 without glymma; gonoforceps with weak to strong dorsal subapical notch on posterior margin; metasoma usually moderately or strongly laterally compressed, T2 1.8-2.3 as long as apical width. Ovipositor 1.4-3.2 as long as hind femur.

Species of *Venturia* described in the nineteenth century were placed in a variety of genera, most being in the catchall groups *Campoplex, Limneria* and *Nemeritis.* Foerster published the generic name *Idechthis* in 1868 but, as was the case for most of his ichneumonid genera, he did not indicate what species should be referred to it. Ashmead placed *oahuensis* Ashmead (= *Campoplex canescens* Gravenhorst) in *Idechthis* in 1901. In the following years, more species were correctly assigned to *Idechthis,* the earliest being *patulus* (Viereck, 1912). Cushman described *nigricoxalis* as a species of *Idechthis* in 1917, but stated in 1921 that he did not believe that it was generically distinct from *Campoplex* (Cushman & Gahan, 1921). Workers in the following years continued to use *Idechthis,* although species that would today be assigned to *Venturia* were sometimes placed in other genera. This was due to the chaotic state of ichneumonid systematics in the first half of the century. Viereck used *Idechthis* beginning in 1912, as either a separate genus associated with *Casinaria* and related genera, or as a subgenus of *Casinaria.* In his description of *patula* in 1912, he states that *Idechthis* is "apparently related" to *Nothanomalon,* which is today considered to be a synonym of *Casinaria.* He evidently had some trouble distinguishing these genera as is evidenced by two specimens of *V. scitula* that were determined by him as belonging respectively to *Neonortonia* and *Ischnoscopus. Neonortonia* is now regarded as a synonym of *Casinaria* and *Ischnoscopus* as a synonym of *Hyposoter.* Although the confusion with *Ischnoscopus* cannot be readily explained, the apical elongation of the propodeum was perhaps responsible for Viereck's troubles with *Idechthis* and *Casinaria* (H. Townes, pers. comm.; see discussion of generic relationships).

The studies of Horstmann (1973), Maheshwary (Gupta & Maheshwary, 1977), and my revision of a New World species group (Wahl, 1984), are the only ones that have dealt with the species of a region as members of *Venturia.* The numbers of species previously described from the various biogeographical regions are as follows:

Western Palearctic (Horstmann, 1973): 11
Eastern Palearctic (Townes *et al,* 1965): 5
Nearctic (Carlson, 1979): 5
Neotropical (Townes & Townes, 1966; Wahl, 1984): 25
Indo-Australian (Gupta & Maheshwary, 1977): 35
Ethiopian (M. Townes, 1973): 8
Total (correcting for duplication and synonymies): 84

BIOLOGY

As for most ichneumonids, knowledge of the biologies of Nearctic *Venturia* is extremely limited. Carlson (1979) stated that *Venturia* species, like those of *Campoplex,* parasitize microlepidoptera that feed in concealment, such as in leaf rolls, buds, and cases. My study supports his observation with the exceptions of *V. nigriscapus* and *townesorum,* members of the Nigriscap-

us Group. They parasitize larger moths, such as Noctuidae and Arctiidae. Other species in the Nigriscapus Group probably use moths in the same size range as hosts. The following summarizes what is known of the host relationships of Nearctic *Venturia:*

V. brachypropodealis Wahl—Tortricidae.

V. canescens (Grav.)—*Anagasta kuehniella* (Zell.) [Pyralidae], *Plodia interpunctella* (Hbn.) [Pyralidae] (These are the most commonly encountered hosts; see Salt (1976) for a discussion of all known natural and experimental hosts).

V. chnaura Wahl—*Fascista cercerisella* (Chamb.) [Gelechiidae].

V. daschi Wahl—*Stenoma* [Stenomidae]; unidentified tortricid sp.

V. finlaysonae Wahl—*Tetralopha aplastella* (Hulst.), *T. asperatella* (Clem.) [Pyralidae].

V. gelechiae (Ash.)—*Fascista cercerisella* (Chamb.) [Gelechiidae] (The information associated with the holotype states that it was reared from *Gelechia celtisella,* now in *Lithocolletes,* a gracillariid leaf miner which is too small to produce a wasp of this size; the name is probably a *lapsus* for *cercerisella*).

V. hibiscellae Wahl—*Chionodes hibiscella* (Busk) [Gelechiidae].

V. marjoriella Wahl—*Polyhymno luteostrigella* (Cham.) [Gelechiidae].

V. micraulax Wahl—*Herculia thymetusalis* (Wlk.) [Pyralidae], *Holcocerina immaculella* McD. [Blastobasidae].

V. nigricoxalis (Cush.)—*Euzophora ostricolorella* Hulst., *E. semifuneralis* (Walk.) [Pyralidae], *Grapholitha molesta* (Busk) [Tortricidae], *Synanthedon exitiosa* (Say), *S. pictipes* (G. & R.) [Sesiidae].

V. nigriscapus (Vier.)—*Acronicta interrupta* Guen., *Bomalocha* sp., *Catacola* sp., *Plathypena scabra* (F.), *Zale* sp. [Noctuidae].

V. platyura Wahl—*Platoeceticus gloveri* Pack. [Psychidae].

V. townesorum Wahl—*Pareuchaetes insulata* (Walker) [Arctiidae].

V. tristis Wahl—Unidentified larva from top of mammoth cactus, Neuvo Leon, Mexico [USNM].

undescribed species—a distorted female and associated male ([USNM], "ex pupae Phycitidae; Nog. 88688 Mexico, at Nogales, Ariz.; 9/28/63; E. Wilson, J. Kaiser, 63-24679") were reared from a phycitine pyralid, many of which are stored products pests or bud worms.

unassociated male—*Meroptera pravella* (Grote) [Pyralidae] ([CISC], Ontario, Westree, emer. 18 Mar. 1966, F.I.S. S65-2404).

Some, but not all, species of *Campoplex* and *Venturia* spin their cocoons in the pupal remains of the host, unlike most Porizontinae which emerge from the host larva and spin the cocoon outside (Carlson, 1979). The following *Venturia* species were found to spin the cocoon inside the host pupa: *brachypropodealis, daschi, marjoriella, micraulax, nigricoxalis, nigriscapus,* and *townesorum.* The remaining species listed above emerge from the host larva.

Finlayson (1975) figured the larvae of eight species of *Venturia,* five of which were treated as undescribed species. Her *Venturia* sp. F is actually a species of *Sinophorus* and sp. D is *V. nigriscapus.* The remaining three species are assigned as follows: sp. B = *V. finlaysonae,* sp. C = *V. daschi,* sp. E = *V. brachypropodealis.*

Venturia species are found in greatest abundance in areas of mixed mesophytic vegetation, although H. Townes (pers. comm.) has noted that they are often found in environments (such as grasslands) that are drier than the usual habitats of porizontines. The species do not seem to be abundant in boreal or xeric environments.

RELATIONSHIPS OF *VENTURIA* WITH OTHER GENERA

Various authors have considered *Venturia* to be related to *Campoplex* and *Casinaria.* Townes erected the tribe Campoplegini (Townes *et al,* 1961; now called Porizontini [Townes, 1971]) to include *Venturia, Campoplex, Sinophorus, Casinaria, Scenocharops,* and *Charops.* Sanborne (1981) resurrected *Sesioplex* from synonymy with *Campoplex.* Horstmann (1970) recognized that *Ichneumon moderator* L., the type species of *Porizon,* was a species related to these genera, regarding it and related species as tenatively belonging in *Venturia* (Horstmann, 1973). Gupta and Maheshwary (1977), Carlson

(1979), and other workers have considered *Porizon* to be a separate genus and I am treating it as such here. Gauld (1976) erected the genus *Sliochia* and indicated that its relationships were with *Echthronomas, Campoctonus,* and other porizontines that possessed a medioventral hair row on the hind basitarsus. On the basis of the structure of the first metasomal segment, I believe that it is related to *Campoplex* and associated genera. *Slenda* was described by Gauld (1984) and he stated that it was related to *Venturia.* I consider it to be a rather derived group of species in *Venturia* and have synonymized it.

Until generic relationships are better known in the Porizontinae, I prefer not to use Townes' tribal classification and will refer to his Porizontini as the *Campoplex* Group. I regard it as a monophyletic assemblage based upon the unique morphology of the first metasomal segment. The ancestral condition is found in *Campoplex* (and further modified in *Venturia, Charops,* etc.) with the suture separating T1 from S1 at the middle, or somewhat below the middle, of the petiole in the basal 0.3 (fig. 3l). S1 is produced basally. In cross section, the petiole is depressed-oval, or somewhat rectangular. The glymma is present only as a groove.

Generic relationships within the *Campoplex* Group are problematical. I shall first discuss the characters of each genus and then return to the problem of their interrelationships.

Campoplex: As presently regarded, there is no one character shared by all its members; it consists of various lineages that lack the characters of the more specialized genera in the *Campoplex* Group. Henry Townes (pers. comm.) believes that it is divisible into three groups: *Pseuderipternoides* Viereck, *Campoplex* s.s., and *Dioratica* Foerster. *Pseuderipternoides* has the gonoforceps elongate and shallowly emarginate on the upper posterior margin, an elongate propodeum, and a laterally flattened ovipositor with a slight dorsal nodus just before the apical notch. *Campoplex* s.s. has the central area broader than in either of the other two groups, the occipital carina usually meeting the hypostomal carina at the mandibular base, and the gonoforceps weakly emarginate in a few species. *Dioratica* has none of the above characters except for some species which possess emarginate gonoforceps, and others that have a nodus similar to *Pseuderipternoides.* It is probably paraphyletic.

Sinophorus: According to Sanborne (1984), *Sinophorus* is monophyletic on the basis of: 1) the elongate larval labial sclerite, 2) the length of the tip of the dorsal valve of the ovipositor, 3) the moderately to strongly arching discoidella vein of the hind wing, and 4) the very wide areola. None of these characters, except 4, is unique to *Sinophorus;* they are scattered throughout *Campoplex* or other genera, although not in the above combination. The elongate larval labial sclerite is found in *Venturia* and *Sesioplex* as well (see below). *Sinophorus* and some species of *Campoplex* have the prelabial sclerite with the stem longer than the arm, while *Venturia* has them about equal in length (Finlayson, 1975). I am unable to polarize the character states at this time.

Sesioplex: According to Sanborne (1983), the only character which presently delimits the genus is the well-developed nodus immediately in front of the dorsal ovipositor notch, although the two Nearctic species have the second recurrent vein perpendicular to the subdiscoideus. As in *Sinophorus,* the petiolar suture is below the middle, a wide propodeal trough is present, and the basal 0.3 of the petiole is rectangular in cross-section. The gonoforceps is not emarginate. The larval labial sclerite is like that of *Sinophorus.*

Venturia: The apex of the propodeum is long, usually reaching the middle of the hind coxa or beyond. The structure of the first metasomal segment is unique (fig. 3n), with the petiolar suture in the middle for the length of the petiole, the petiole more or less circular in cross section throughout its length, and S1 of uniform depth and without any lateral grooves or impressions. *Campoplex, Sinophorus,* and *Sesioplex* usually have small but distinct grooves on S1 that parallel the petiolar suture. T1 is without the remnant groove of the glymma (such as is found in *Campoplex* or *Sinophorus*) or with only very faint traces of it (as in *V. micraulax*). The metasoma is moderately (occasionally strongly) compressed and T2 is elongate (2.2-2.8 as long as apical width), unlike the weakly compressed metasoma and short T2 (1.4-1.6 as long as apical width) of most *Campoplex* or *Sinophorus.* The gonoforceps is weakly to strongly emarginate. As in *Sinophorus,* the larval labial sclerite has an elongate ventral portion.

Slenda: Examination of the type species of *Slenda (S. ocypeta)* as well as an undescribed species from Australia has convinced me that this genus represents a species group of *Venturia.* To confer generic status upon it would render *Venturia* paraphyletic and I am thus treating it as a synonym of that genus. The elongate propodeum, structure of the FMS, and compressed metasoma are all typical of *Venturia.* The derived characters of *Slenda* include the medially incised apical margin of the tergites, lack of an areolet, undifferentiated epipleurum of T3, and the

short compressed ovipositor. Although specimens of *Venturia serpentina* were not examined, the description in Gupta & Maheshwary (1977) reveals that the synapomorphies of *Slenda* appear to be present in this species as well.

Porizon: I do not agreee with Horstmann's (1973) tenative assignment of this genus to *Venturia.* The first metasomal segment is like that of *Campoplex* except that the glymma is absent.

Sliochia: This is an unusual genus, resembling *Porizon* in some respects (lack of an areolet, shape of the central area, mesosoma with small and weak punctures on a strongly granulate surface) but is distinct in that the genal margin of the eye is slightly emarginate, the hypostomal and occipital carinae meet at the mandibular base, the scape is unusually long, the hind basitarsus has a medioventral hair row, and the marginal cell is short. The morphology of the first metasomal segment places it within the *Campoplex* Group.

Casinaria: This genus, along with *Charops* and *Scenocharops,* is quite distinct from other genera in the *Campoplex* Group on the basis of the short ovipositor (about equal to the apical depth of the metasoma), strongly receding gena, emargination of the eyes opposite the antennal socket, and a narrow lateral area of the pronotum with a long and flange-like epomia. The narrow gena and short ovipositor are correlated with to parasitism of naked larvae.

Casinaria has been associated with genera of the *Campoplex* Group, and especially with *Venturia,* on the basis of the similar first metasomal segment (fig. 3o-p), which is without a glymma, circular in cross section, and the petiole has the suture far above the middle for its entire length. Additionally, most of the species of *Casinaria* (and *Charops* and *Scenocharops* as well) have the propodeal apex prolonged between the hind coxae, as does *Venturia.* I was initially of the opinion that *Casinaria* was not related to *Campoplex* or *Venturia* and was related instead to genera such as *Hyposoter, Phobocampe,* etc, with the first metasomal segment being a product of convergent evolution. Examination of *Casinaria eupitheciae* Viereck, as well as some related species, showed it possesses several plesiomorphic characters, especially with regard to the first metasomal segment (fig. 3o). The FMS is shorter than is usual for most *Casinaria* and S1 is deeper in its basal 0.3. S1 also has a weak groove paralleling the petiolar suture. This is usually absent in more derived species. The propodeal carinae, which are usually partly absent in *Casinaria,* are strong and reveal a wide central area with the juncture of the areola-petiolar area weakly constricted. The propodeal neck is almost absent and the metasoma is weakly compressed with T2 short (about 1.3 as long as apical width). I believe that these characters, especially the first metasomal segment and wide central areas, reflect the origin of *Casinaria* from a species like *Campoplex.* The resemblance of the FMS in *Venturia* and *Casinaria* is a result of convergence.

Charops: This genus is like the more derived species of *Casinaria,* as it has the propodeal apex prolonged, the gena narrowed, and the ovipositor short. It differs in that the petiolar suture runs along the upper margin of the petiole, the mesopleural sulcus is not impressed, the areolet is absent, and the second recurrent vein is perpendicular to the subdiscoideus.

Scenocharops: Similar to *Charops* except the second recurrent vein is inclivous, the areolet is present, the propodeal carinae are absent, and the base of the petiole has a distinct lateral flange.

A generally confusing picture emerges of the relationships of the genera (as presently delimited). Characters such as the subapical nodus of the ovipositor, the juncture of the occipital and hypostomal carinae at the mandibular base, the emargination of the gonoforceps, and the presence of a propodeal trough are spotty in their distributions. While *Pseuderipternoides, Campoplex s.s., Porizon, Sliochia,* and *Sinophorus* are each probably monophyletic, their relationships to each other and the probably paraphyletic *Dioratica* are unknown. In *Sesioplex,* the relationship of the two Nearctic species to the Palearctic species, based as it is on a character (subapical nodus of the ovipositor) found throughout *Dioratica,* is an open question. An intensive study of these groups on a world-wide scope will lead to some changes in classification.

Venturia is monophyletic, as witnessed by the unique structure of the first metasomal segment, prolonged apex of the propodeum, and moderately compressed metasoma and elongate T2. The structure of the FMS is the strongest arguement for its monophyly. It is not possible at present to determine the sister-group of *Venturia.* The shape of the larval labial sclerite suggests possible relationships with *Sinophorus* and *Sesioplex.* Some species of *Campoplex* also have the metasoma moderately compressed and T2 elongate. A more detailed picture of the relationships of the subgroups of *Campoplex* is needed before more can be said, since some *Campoplex* larvae have tendencies toward an elongate labial sclerite. As mentioned in the section on biology, some *Campoplex* and *Venturia* have the unique habit (for porizontines) of

spinning their cocoon in the host pupa. The distribution of this character is spotty throughout the two genera but could be of use in determining relationships.

Casinaria, Charops, and *Scenocharops* form a monophyletic group, based on the emarginate eyes, dorsal postion of the petiolar suture, narrow gena, short ovipositor, and narrow lateral area of the pronotum. While one might argue that these genera arose from a species of *Venturia,* with the petiolar suture being shifted dorsally and concommitant changes occurring due to parasitism of naked larvae, I think it unlikely. The shape of the larval labial sclerite of *Casinaria* is ovoid and without an elongate ventral portion, similar to the larval morphology in *Campoplex.* The *Casinaria* lineage probably originated from an ancestor with a first metasomal segment similar to that of *Campoplex.* The elongation of the propodeal neck and compression of the metasoma, found also in *Venturia,* would thus be parallelisms.

Charops and *Scenocharops* are each monophyletic but *Casinaria* is probably paraphyletic with respect to these genera.

Relationships Within *Venturia*

Given the confused picture of generic relationships within the *Campoplex* Group, a problem arises of what to use as an outgroup for *Venturia.* I have decided not to use *Sinophorus* or *Casinaria* and related genera, considering them to be too specialized. The lineages within *Campoplex* s.l. have been used instead. When more than one state is found in the outgroup, the widely distributed state is considered to be plesiomorphic and the restricted state is considered to have arisen more than once. Although this is not in accord with the rigorous methods of Watrous and Wheeler (1981), it is the most practical course at this time. A list of characters that I initially considered follows, along with discussions as to their suitability.

1. Malar space. A value of 0.3-0.4 is found throughout the outgroup and is considered ancestral for *Venturia.* Values of: 1) 0.5 and 2) 0.6-0.7 are considered derived.

2. Head shape. Most *Venturia* have the head roughly triangular in frontal outline (fig. 20e) but a number of small species have the head roundish (fig. 19a-k). This former state is considered ancestral. Some smaller *Campoplex,* however, also have the roundish head shape and further research could reverse the decision.

3. Supraclypeal area. The outgroup has the surface granulosopunctate; the derived condition is coarsely rugosopunctate with weak granulation.

4. Genal width. In the outgroup and most *Venturia,* the gena is usually narrower in females. The derived condition is to have the gena wide (0.5) and flattened in both sexes.

5. Compound eyes ventrally convergent in females. This is apomorphic within *Venturia* (fig. 19a).

6. Mesonotal profile. A more or less strongly produced profile (as in fig. 22b) is found in the outgroup and most *Venturia.* Reduction of the profile has apparently occurred several times.

7. Mesopleural outline. This varies from weakly elongate (fig. 23a) to strongly elongate (fig. 23m). An intermediate shape is probably ancestral for *Venturia* as it is found in the outgroup as well.

8. Surface sculpture of upper corner of pronotum. A moderately to strongly granulate surface with few or no punctures is found in the outgroup and some *Venturia.* The following derived states are found: 1) predominately granulate with more punctures concentrated along the upper margins; 2) granulate with numerous punctures throughout, giving a shagreened appearance; 3) rugosopunctate with the punctures distorted (at least to some degree) by the rugae, usually without granulation; 4) numerous strong punctures on a smooth surface. It is unclear whether some of the states (esp. 1 & 2) are homologous for the species involved.

9. Mesopleural punctation. The condition in the outgroup is for the punctures to be 0.1-0.2 OD and deep. Coarse punctation is 0.2-0.3 OD and shallow.

10. Mesopleural granulation. This varies from 1) strong to 2) moderate and 3) weak or smooth. State 1 is found in the outgroup and some *Venturia.*

11. Hypoepimeral punctation. The punctures along the dorsal and posterior margins are absent in the outgroup, but whether the sparse condition (1) is antecedent to the dense condition (2) is unknown.

12. Metapleural surface. The outgroup has discrete punctures on a more or less granulate surface. The derived conditions are either: 1) completely coarsely rugosopunctate, or 2) with the upper half coarsely punctate and the lower portion coarsely rugosopunctate.

13. Scutellar surface. In the outgroup, the surface is similar to the metapleurum; the derived conditions are either: 1) the surface

coarsely rugosopuncatate on a granulate surface, or 2) coarsely punctate on a smooth surface.

14. Propodeal carinae. While the propodeal carinae provide a rich variety of patterns and are of great value in distinguishing species, trying to find homologous patterns is extremely difficult. I tried arranging the forms by length (elongate, somewhat elongate, and as long as wide; see "Materials and Methods", section 8 of the descriptions) and by the distance to the base of the areola from the base of the propodeum. This led to artificial units and was abandoned. At present, only relatively few of the forms can be recognized as homologous. They are: 1) the somewhat elongate, pointed areola of the Hadra Group (fig. 16c-e), and 2) the pattern found in some of the Nigriscapus Group (fig. 18h). The outgroup has the areola as long as wide and close to the basal propodeal margin.

15. Areolar surface. The outgroup and some *Venturia* have the surface granulate. Derived states are: 1) weakly granulate with some rugae; 2) granulosopunctate; 3) smooth and rugose; 4) granulate with some scattered punctures.

16. Propodeal neck. The neck is absent in the outgroup. Three states can be found in *Venturia:* 1) 0.3-0.4 as long as wide; 2) 0.5 as long as wide; 3) 0.6-0.7 as long as wide. The polarity is unknown.

17. Hind femur. The ratio of length/width is usually from 4.2-5.7, but seems to be usually correlated with body size, the shorter femora being associated with smaller species.

18. Nervulus vein. In the outgroup, it is opposite or slightly distal to the basal vein; the derived condition is distal by about 0.3 its length.

19. Postnervulus vein. It is intercepted at or near the midlength by the subdiscoideus in the outgroup and most *Venturia.* The derived condition is interception at the anterior 0.3.

20. First metasomal segment. Although the FMS is significantly different from that of *Campoplex,* the ancestral condition is probably to have the petiole about 1.5 as long as the postpetiole (the value found in the outgroup), and postpetiole rather low; fig. 13f is an example of this state. A common derived state (1) is to have the petiole more elongate (1.7 as long as the postpetiole) and the postpetiole high; this has probably arisen several times. A further derivation (2) of this is found in the Nigriscapus Group in which the petiole is 1.9 as long as the postpetiole and the postpetiole is low. Another state (3) is found in the Hadra Group, in which the petiole is stout and the postpetiole is low (fig. 13o). In between these states are a variety of forms that do not distinctly fit into any category.

21. Second tergum. The condition in the outgroup is T2 short (around 1.4-1.6 as long as wide). The derived state (a) for *Venturia* is longer (2.2-2.8). A further derivation (b) is a value of 3.5.

22. Metasomal compression. A weakly compressed metasoma (fig. 3i) is found in the outgroup. *Venturia* appears to have a moderately compressed metasoma (fig. 3j) as an apomorphy (1). A strongly compressed metasoma (2) is found in some species of *Venturia* (fig. 3k).

23. Metasomal color. A completely fuscous metasoma is the usual condition in the outgroup. Four derived states are observed: 1) fuscous except for brownish red ventral lateral areas of T5-7; 2) T2, basal 0.5 of T3 and midlines of T4-7 fuscous, remainder brownish red; 3) brownish red with T2 (sometimes) and basal 0.5 of T3 fuscous; 4) completely brownish red except for the fuscous petiole. Although this character can be striking, H. Townes (pers. comm.) has found a high correlation of extensive brownish red with open habitats, suggesting that the color could be subject to a large number of parallelisms and reversals.

24. Ovipositor length. The value for the outgroup and most *Venturia* is 2.4-3.2 as long as the hind femur. Derived states are: 1) 1.4-2.2, and 2) 3.5-3.7.

In addition to the above characters, the following apomorphies are found within the Nigriscapus Group. See Wahl (1984) for full discussion.

25. The occipital carina is medially straight.

26. The transverse rugae on the polished lateral area of the pronotum adjacent to the collar area are absent or weak.

27. The upper corner of the lateral area of the pronotum has a smooth or polished surface and the punctures separated by about 0.5 their diameter.

28. The upper anterior region of mesopleurum has the area immediately adjacent to the scrobal groove with the transverse rugae absent or reduced, with few or no punctures; the surface granulation is absent so this area appears to be an extension of the hypoepimeron.

29. The scape, pedicel, tegula, coxae, and hind femur are black-fuscous. Simultaneous possession of dark coloration on these parts is rare in *Venturia.*

30. The hind femur is fuscous; this appears independently of character 29.

31. Second lateral area of propodeum is short and rectangular.

Due to potential allometric effects or difficulty in establishing discrete characters, variables 2, 5, 6, 15, and 16 were not used. The remaining characters were used in the PAUP program of David Swofford (Illinois Natural History Survey). All character states were run unordered, as transformation series were almost impossible to determine. Despite the use of various options and deletions of certain characters (such as 7, 9, and 12), only three monophyletic groups could be found; the rest of the species belonging to groups that shifted in composition from run to run. Rampant homoplasy and unlikely character state transformations were the rule.

The failure to find stable groups may be because many characters were of low complexity and seemed prone to reversal and parallelism; surface granulation, metasomal color, hypoepimeral punctation, and length of the propodeal neck fall in this category. Any attempt to classify the shape of the central area of the propodeum in a rigorous way was unsatisfactory, leaving only two patterns that could be used for more than one species. As only 50% of the species have associated males, more extensive use of male genitalia was ruled out.

Venturia canescens was not considered in the analysis since it is an introduced Palearctic species.

Characters in the cladograms discussed below are numbered as in the above discussion; the various states are refered to as 12-1, 12-2, etc. Reversals are marked with an "X" instead of a tick mark.

The species in the Gelechiae Group *(anareolata, chnaura, gelechiae, marjoriella, masoni, mayi* and *texana)* are united by the ventrally convergent compound eyes. They retain a number of plesiomorphies (upper corner of pronotum granulate with few punctures, strongly granulate mesopleurum, and completely fuscous-dark brown metasoma). There is variation in the shape of the central area and FMS but further analysis was not undertaken.

The relationships of the Hadra Group *(brachypropodealis, erythrogaster, finlaysonae, hadra,* and *scitula)* are portrayed in fig. 5a; the short T2 (21) and weakly compressed metasoma (22) that unite these species are interpreted as reversals to the state found in *Campoplex.* The stout FMS and short (0.3-0.4) propodeal neck are also synapomorphies of the group. *V. scitula, brachypropodealis,* and *erythrogaster* are united by the possession of a pointed, somewhat elongate areola with rugae on a smooth surface (14-1). The extreme reduction of fuscous on the metasoma (23-4) unites *brachyproprodealis* and *erythrogaster.* Reduced metasomal fuscous areas (23-3) and a long (2.7-3.0) ovipositor were apparently possessed by the ancestor of the group. Although *longicuspis* also has a short T2 and a weakly compressed metasoma, the more elongate propodeal neck, long petiole and high postpetiole, and short (2.1-2.2) ovipositor leads me to believe that its resemblance is due to convergence.

The Nigriscapus Group has been expanded from my earlier conception (Wahl, 1984) to include *anchisteus, compacata,* and *sokanakiakorum* (fig. 5b). The synapomorphy for the group is the short (1.4-2.2) ovipositor (24-1). Relationships among the species treated in 1984 have not changed, but some of the characters thought to be synapomorphic for the Nigriscapus Group now subtend *anchisteus* as well. Ancestral metasomal coloration for the Nigriscapus Group s.l. is probably as in character 23-3; given this, the presence of 23-2 is apomorphic for a number of species.

KEY TO FEMALES OF *VENTURIA* NORTH OF CENTRAL AMERICA

1. Pronotum with upper corner of lateral area with surface granulate, punctures either sparse or scattered along margins (fig. 1a), not close and distorted; head with frontal outline often roundish (figs. 19a-k); length usually 4.5-7.0 mm; hypoepimeral punctation absent or sparse; metasoma with brownish red confined to T2-3 and narrow midlines of T4-7 2

— Pronotum with upper corner of lateral area with surface usually not granulate, either rugosopunctate (fig. 1e-f), closely punctate (fig. 1d),

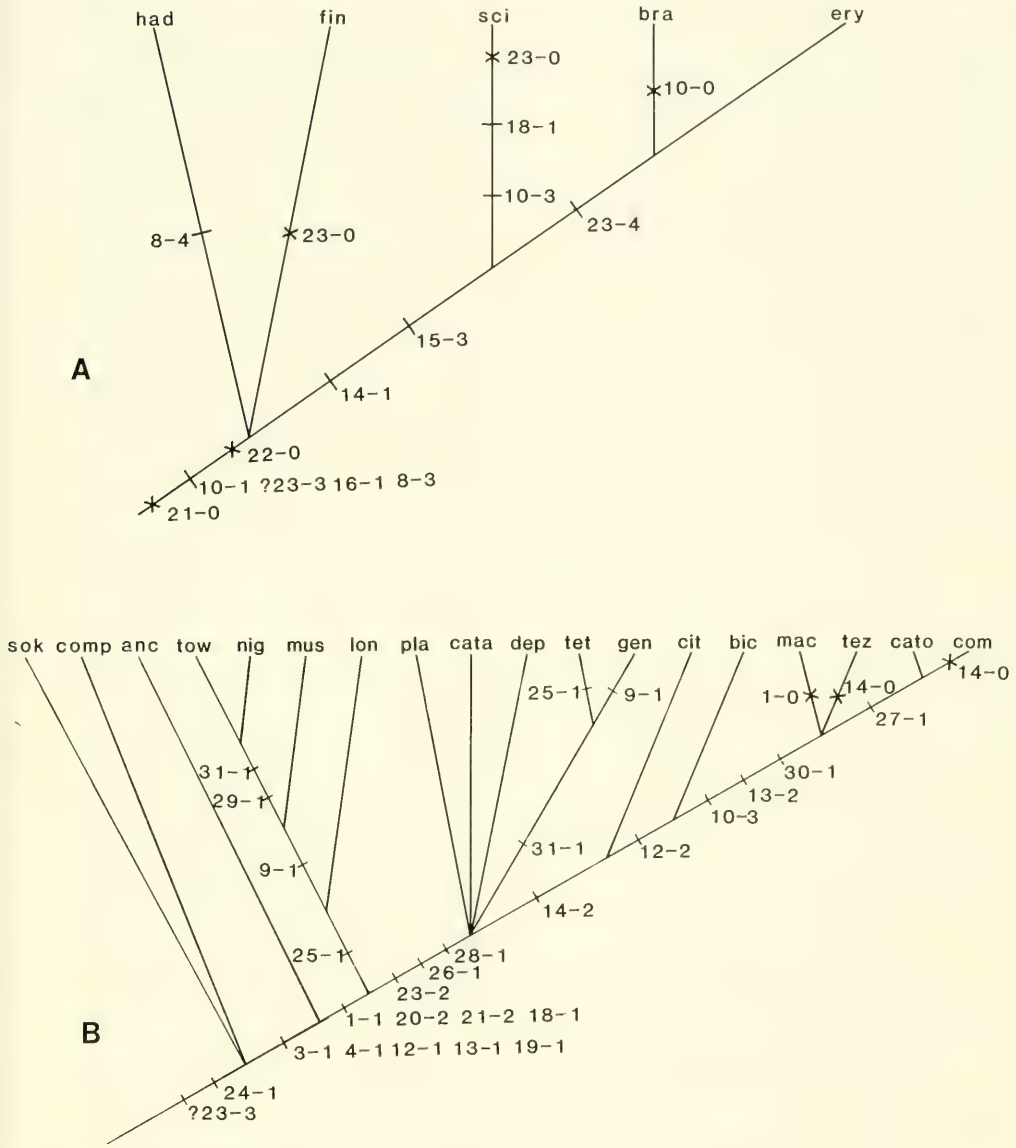

FIGURE 5. A, cladogram of Hadra Group. B, cladogram of Nigriscapus Group.

or else with dense shallow punctures on granulate surface (appearing shagreened, fig. 1b-c); if punctures concentrated along margins, they are separated by about 0.3 their diameter or contiguous, and somewhat distorted; head with frontal outline more elongate (fig. 20e); length usually 7.0 mm or longer; hypoepimeral punctation usually sparse to dense; metasoma usually with considerable amount of brownish red 21

2. Metasoma fuscous except for brownish red areas of apex of T2 and lower lateral regions of T4-7. 3

— Metasoma dark brown-fuscous except for brownish red apex of T2 . . 9

3. Mesosoma deep brownish red; hind femur brownish red; FMS short and stout (fig. 13f) and piceous-deep brown; areolet present; propodeum with central area wide (fig. 15k) . . . . . *mulleola*

— Mesosoma fuscous; hind femur

brownish red or dark brown-fuscous; FMS longer and fuscous; areolet present or absent; propodeum with central area sometimes narrower and constricted at juncture of areola-petiolar area 4

4. Pronotum with lateral area having rugae absent or very weak, surface granulate; propodeum with juncture of areola-petiolar area strongly constricted (fig. 15j & 14u) 5
— Pronotum with lateral area having rugae present; propodeum with juncture of areola-petiolar area variable. 6
5. Areolet absent; propodeum with central area as in fig. 15j, carinae all strong; ovipositor about 2.5 as long as hind femur; length about 4.3 mm . . . . . *pumila*
— Areolet present; propodeum with central area as in fig. 14u, carinae apically weaker; ovipositor about 3.0 as long as hind femur; length about 5.4 mm . . . . . *durangensis*
6. Areolet absent; genal width about 0.3; propodeum with first lateral area granulate with distinct punctures; mesopleurum moderately granulate; ovipositor about 2.0 as long as hind femur; FMS elongate with postpetiole low (fig. 13b) . . . . . *anareolata*
— Areolet present; genal width about 0.4; propodeum with first lateral area granulate without punctures or with punctures indistinct; mesopleurum strongly granulate; ovipositor 2.7-2.9 as long as hind femur; FMS shorter and postpetiole higher 7
7. Propodeum with neck about 0.8 as long as wide and with central area as in fig. 14k; mesonotal profile not produced (fig. 22e) . . . . . *mayi*
— Propodeum with neck about 0.6 as long as wide and with central area not as above, areola wider (figs. 15d & 15l); mesonotal profile strongly produced (figs. 22f & 24f). 8
8. Propodeum with central area as in fig. 15d, areola basally rounded; mesopleurum with punctures separated by 0.5-1.0 their diameter, on strongly granulate surface; pronotum with upper corner of lateral area strongly granulate with weak punctures . . . . . *amplareolata*
— Propodeum with central area as in fig. 15l; mesopleurum with punctures separated by 0.3-0.5 their diameter on weakly granulate surface; pronotum with upper corner of lateral area moderately granulate with scattered normal punctures . . *capulata*
9. Fore and middle coxae dark brown-fuscous 10
— Fore and middle coxae yellow (at least apical 0.5 of fore coxa) 15
10. Ovipositor 3.6-3.7 as long as hind femur. . . . . *spectabilis*
— Ovipositor 2.1-2.7 as long as hind femur; otherwise not as above . . . 11
11. Propodeum with areola as long as wide and granulate; length 5.5-7.0 mm; mesopleurum weakly-moderately granulate; hind femur brownish red; compound eyes ventrally convergent . . . . . *gelechiae*
— Not with above combination of characters 12
12. Propodeum with areola elongate and juncture of areola-petiolar area strongly constricted (fig. 14x); compound eyes with inner ventral margins parallel; mesopleurum with punctures separated by 1.0-2.0 their diameter; hind leg with first trochanter, femur, and tibia, dark brownish red; ovipositor about 2.4 as long as hind femur . . . . . *pullata*
— Propodeum with areola shorter and juncture of areola-petiolar area not as constricted (figs. 14v, 15g, 16k); otherwise not as above 13
13. T3-7 deep brownish red with lighter highlights; hind leg with first trochanter and femur light brownish red; length 7.6 mm . . . . . *latrunculus*
— T3-7 dark brown-fuscous; hind leg with first trochanter and femur often dark brown; length 3.4-4.7 mm . . 14
14. Compound eyes with inner ventral margins parallel; hind femur light brownish red . . . . . *australis*
— Compound eyes ventrally convergent; hind femur light brownish

red to dark brown-fuscous . . . . . *marjoriella*

15. Propodeum with areola as long as wide and junction of areola-petiolar area weakly constricted (figs. 15e, 15g) 16
— Propodeum with areola somewhat elongate or elongate, and juncture of areola-petiolar area moderately to strongly constricted (figs. 15a, 15b, 15g, 17j, 18l) 17
16. Pronotum with surface of upper corner with scattered punctures; propodeum with second lateral area weakly rugosopunctate; mesopleurum weakly to moderately granulate; length 5.4-7.1 mm . . . . *gelechiae*
— Pronotum with surface of upper corner with punctures absent or sparse; propodeum with second lateral area granulate with regular punctures; mesopleurum strongly granulate; length 4.4-5.6 mm . . . . . *marjoriella*
17. Propodeum with areola narrow (figs. 15b, 17j, 18l) 18
— Propodeum with areola wider (figs. 15a & 15g) 20
18. Propodeum with central area as in fig. 15b, base of areola near basal propodeal margin; ovipositor about 3.0 as long as hind femur . . . *chnaura*
— Propodeum with central area as in figs. 17j & 18l; ovipositor either 2.4 as long as hind femur and straight, or 2.8-2.9 as long as hind femur and strongly curved. 19
19. Propodeum with central area as in fig. 17j; ovipositor about 2.4 as long as hind femur and straight; mesopleurum with surface moderately granulate; length 5.1 mm . . . . *texana*
— Propodeum with central area as in fig. 18l; ovipositor 2.8-2.9 as long as hind femur and strongly curved; mesopleurum with surface weakly granulate; length 6.0-6.4 mm. . . . . *masoni*
20. FMS with petiole having two weak dorsolateral grooves; ovipositor strongly curved and with weak dorsal nodus just before apical notch (fig. 4e); hind first trochanter fuscous; compound eyes with inner ventral margins parallel . . . . . *eremna*
— FMS without dorsolateral grooves; ovipositor moderately curved and without nodus; hind first trochanter yellow; compound eyes ventrally convergent . . . . . *marjoriella*
21. Metasoma weakly compressed; T2 1.4-1.5 as long as apical width; propodeum with neck 0.3-0.4 as long as wide; FMS as in fig. 13o, petiole stout and postpetiole low; ovipositor about 3.0 as long as hind femur and not laterally compressed (Hadra Group) 22
— Not with above combination of characters 26
22. Metasoma fuscous 23
— Metasoma with fuscous coloration confined to petiole, or to T2 and basal 0.3 of T3 24
23. Hind leg with first trochanter, femur, tibia, and tarsus dark brown; propodeum with areola elongate (fig. 16a) and granulate; mesopleurum with punctures separated by about their diameter . . . . . *finlaysonae*
— Hind leg with trochanters fuscous-black and femur, tibia, and tarsus deep brownish red; areola as long as wide and sharply pointed (fig. 16d), smooth with transverse rugae; mesopleurum with punctures separated by 0.3-0.5 their diameter . . . . *scitula*
24. Propodeum with areola elongate (fig. 16b) and granulate; T2 with basal 0.7 and T3 with basal 0.3, fuscous; mesopleurum weakly granulate . . . . . *hadra*
— Propodeum with areola somewhat elongate (fig. 16c & 16e) and smooth with transverse rugae; metasoma with fuscous coloration confined to petiole; mesopleurum with granulation weak or strong 25
25. Mesopleurum weakly granulate; hind leg with trochanter yellowish; length 10.2-10.4 mm . . . . *erythrogaster*
— Mesopleurum strongly granulate; hind leg with trochanter dark brown-fuscous; length 7.7-8.0 mm . . . . . *brachypropodealis*
26. Ovipositor 1.3-2.2 as long as hind femur; metasoma moderately or

strongly compressed, and with fuscous coloration either confined to T2 and basal 0.5 of T3, or to T2-3 and narrow midlines of T4-7 27

— Ovipositor almost always 2.5 as long as hind femur or longer; otherwise not as above 37

27. Scutellum and metapleurum distinctly punctate; fore wing with nervulus opposite basal vein. 28

— Scutellum and metapleurum coarsely rugosopunctate; fore wing with nervulus distal to basal vein by about 0.3 length of nervulus 29

28. Mesosomal profile as in fig. 24m; ovipositor with apex slightly upcurved; propodeum with central area as in fig. 18b . . . . . *compacata*

— Mesosomal profile as in fig. 24l, more elongate; ovipositor straight; propodeum with central area as in fig. 18c, areola narrower. . . . . *sokanakiakorum*

29. Fore wing with postnervulus intercepted at midlength by subdiscoideus; metasoma moderately compressed; T2 about 2.6 as long as apical width; malar space about 0.3 as long as basal mandibular width. . . . . *anchisteus*

— Fore wing with postnervulus intercepted at anterior 0.3 by subdiscoideus; metasoma strongly compressed; T2 about 3.2 as long as apical width; malar space about 0.5 as long as basal mandibular width. 30

30. Fore and middle coxae with basal 0.7 black or dark brown 31

— Fore and middle coxae predominately yellow, although with varying amounts of basal dark coloration 32

31. Propodeal carinae weak apically, petiolar area with reticulate rugae (fig. 18e); mesopleurum weakly granulate; middle femur yellowish with apical 0.2 of dorsal surface brown; FMS with postpetiole brownish red, same color as T3-7 . . . . . *townesorum*

— Propodeal carinae uniformly strong, petiolar area with strong transverse rugae; mesopleurum strongly granulate; middle femur dark brown except for yellow median dorsal stripe; FMS with postpetiole fuscous or deep brown . . . . . *nigriscapus*

32. Scape ventrally yellow or reddish yellow. 33

— Scape ventrally dark brown-fuscous, sometimes with lighter apical area 36

33. Scape reddish yellow ventrally, at least basally 34

— Scape yellow ventrally 35

34. Propodeum with central area as in fig. 18h: juncture of areola-petiolar area not constricted (or only weakly so in some males), median longitudinal carinae roughly parallel and often weak and irregular in height and outline; mesopleurum smooth or occasionally weakly granulate . . . . . some specimens of *macilenta*

— Propodeum with central area as in fig. 18i: juncture of areola-petiolar area constricted, median longitudinal carinae strong and rectangular in height and outline; mesopleurum smooth. . . . . *tezcatlipocai*

35. FMS with at least petiole and sometimes part of postpetiole piceous or black, postpetiole brownish red; propodeum with central area as in fig. 18h, petiolar area with transverse rugae; mesopleurum with punctures separated by 0.3-0.5 their diameter on weakly granulate or smooth surface; length 9.0-9.4 mm . . . *macilenta*

— FMS brownish red, although basal 0.6 can have traces of darkening; propodeum with central area as in fig. 18g, carinae strong basally and becoming weaker apically, petiolar area with reticulate rugae; mesopleurum with punctures separated by 0.2-0.5 their diameter on strongly granulate surface; length 12.9-13.7 mm. . . . . *musae*

36. Hind femur fuscous or dark brown; mesopleurum weakly granulate or smooth; propodeum with central area as in fig. 18h, median longitudinal carinae usually weaker than basal transverse carina; T3-7 with midlines narrowly fuscous . . *macilenta*

— Hind femur brownish red; mesopleurum moderately granulate; propodeum with central area as in fig. 18f, carinae uniformly strong; T3-7 rarely with hints of fuscous . . . . . *nigriscapus*

37. Metasoma completely dark brown or fuscous except for brownish red apex of T2 38
— Metasoma brownish red, at least on lower lateral 0.5 of T4-7 40

38. Fore and middle coxae yellow . . . . . *hibiscellae*
— Fore and middle coxae fuscous-black 39

39. Ovipositor strongly curved, apex elongate (fig. 4c); mesopleurum weakly granulate; hind leg with trochanters and femur fuscous; propodeum with areola granulate with transverse rugae . . . . . *taneces*
— Ovipositor moderately curved, apex not elongate; mesopleurum moderately granulate; hind leg with second trochanter yellow and femur dark brownish red; propodeum with areola granulate . . . . . *nickelseni*

40. Metasoma weakly compressed; T2 1.5-1.6 as long as apical width . . . 41
— Metasoma moderately-strongly compressed; T2 greater than 1.9 as long as apical width 43

41. Ovipositor 2.1-2.2 as long as hind femur, not strongly laterally compressed; pronotum with upper corner of lateral area rugosopunctate on smooth surface; propodeum with areola as long as wide, granulate with weak transverse rugae (fig. 17i) . . . . . *longicuspis*
— Ovipositor 2.6-2.8 as long as hind femur, strongly laterally compressed; pronotum with upper corner of lateral area rugosopunctate on strongly granulate surface; propodeum not as above 42

42. Propodeum with areola as long as wide, broad (fig. 15c); propodeal neck about 0.4 as long as wide; ovipositor with apex elongate (4d) . . . . . *gaesata*
— Propodeum with areola elongate (fig. 17h); propodeal neck about 0.6 as long as wide; ovipositor with apex not elongate . . . . . *platyura*

43. Pronotum with upper corner having shallow punctures on strongly granulate surface, appearing shagreened (fig. 1b-c) and with no traces of rugosity 44
— Pronotum with upper corner rugosopunctate or closely punctate, on smooth or weakly granulate surface 45

44. Propodeum with areola as long as wide or somewhat elongate (fig. 17k); ovipositor 2.6-3.1 as long as hind femur; length 5.1-8.6 mm . . . . . *micraulax*
— Propodeum with areola elongate (fig. 17f); ovipositor 3.0-3.1 as long as hind femur; length 7.7-11.1 mm . . . . . *erythropus*

45. Propodeum with only basal transverse, pleural, and parts of apical transverse carinae present, surface uniformly covered by punctures on weakly granulate surface; ovipositor about 2.6 as long as hind femur; gena flattened and with width of 0.4; mesosomal profile as in fig. 24i. . . . . *punctata*
— Propodeum with full complement of carinae, surface not uniformly punctate; otherwise not as above. 46

46. Hind femur about 9.1 as long as wide; FMS with postpetiole elongate and low (fig. 14m); gena with width of 0.5, strongly receding (fig. 21s); length 10.5-11.6 mm . . . . . *prolixa*
— Hind femur about 6.2 as long as wide or shorter; otherwise not as above 47

47. Pronotum with upper corner having strong punctures concentrated on margins, separated by about 0.3 their diameter or contiguous, on granulate surface. 48
— Pronotum with upper corner uniformly rugosopunctate or closely punctate, on smooth surface 49

48. Propodeum with central area as in fig. 18a, areola granulate; metasoma strongly compressed; middle femur brownish red, hind femur occasionally dark brown . . . . . *daschi*

— Propodeum with central area as in fig. 17l, areola granulate with transverse rugae; middle and hind femora dark brown . . . . *fuscifemorata*

49. Metasoma with T2-3, and at least midlines of T4-9, fuscous 50
— Metasoma with fuscous coloration confined to T2 or T3 52

50. Ovipositor strongly curved, apex with two nodi just before dorsal notch (fig. 4a); metasoma with brownish red coloration confined to lower lateral 0.5 of T4-7, otherwise fuscous; mesopleurum with normal punctures on moderately granulate surface; propodeum with areola granulate with weak transverse rugae . . . . . *dreisbachi*
— Ovipositor not strongly curved and without apical nodi; otherwise not as above 51

51. Propodeum with central area as in fig. 17b, areola granulate; mesoplerum with deep punctures separated by about 0.3 their diameter, on strongly granulate surface; hind trochanters yellow; subalar ridge weakly rugosopunctate . . . . *hibiscellae*
— Propodeum with central area as in fig. 17a, areola narrower and smooth with weak transverse rugae; mesopleurum with normal punctures separated by 0.3-0.5 their diameter, on moderately granulate surface; hind trochanters often brownish; subalar ridge punctate . . . . . *canescens*

52. Ovipositor about 2.8 as long as hind femur, straight except for sharply upcurved apex, and cylindrical; propodeum with areola about as long as wide (fig. 18j); clypeus rather small and head roundish in frontal profile (fig. 21c); mesopleurum weakly granulate . . . . . *licina*
— Ovipositor either uniformly curved or with some lateral compression; otherwise not as above 53

53. T2 about 2.8 as long as apical width, metasoma strongly compressed; ovipositor about 2.4 as long as hind femur, straight; T3-7 brownish red; trochanters yellow; propodeal carinae as in fig. 18k. . . . . *floridensis*
— Not with above combination of characters 54

54. Coxae dark brown-fuscous; trochanters and remainder of hind leg brown; propodeum with central area as in fig. 16i, carinae irregular in height and outline, areola smooth with transverse rugae; length 8.4-11.4 mm. . . . . *nigricoxalis*
— Fore and middle coxae predominately yellow; fore and middle trochanters yellow; otherwise not as above 55

55. Mesopleurum with scrobe not a distinct pit; mesopleural suture with transverse rugae weak or absent; propodeum with apical 0.5 having carinae weak or absent; trochanters yellow; length 6.5-7.2 mm . . . *sculleni*
— Mesopleurum with scrobe a distinct pit; mesopleural suture with transverse rugae present and strong; propodeum with carinae uniformly strong; hind leg with trochanters sometimes brown; usually larger. 56

56. Ovipositor 2.4-2.6 as long as hind femur; propodeum with juncture of areola-petiolar area strongly constricted (fig. 16f); hind leg with trochanters yellow . . . . . *portalensis*
— Ovipositor 2.9-3.2 as long as hind femur; otherwise not as above . . . 57

57. Propodeum with areola elongate and narrow (fig. 17e); antenna with 34 flagellomeres; hind leg with trochanters yellow; metasoma strongly compressed . . . . . *tristis*
— Propodeum with areola wider (fig. 17g); antenna with 40-41 flagellomeres; hind leg with trochanters brown; metasoma moderately compressed . . . . . *micheneri*

KEY TO MALES OF *VENTURIA* NORTH OF CENTRAL AMERICA

1. Fore wing with postnervulus intercepted at anterior 0.3 by subdiscoideus and nervulus distal to basal vein by about 0.3 length of nervulus 2

— Fore wing with postnervulus intercepted at midlength by subdiscoideus and nervulus opposite basal vein 3

2. Mesopleurum with punctures separated by about 0.3 their diameter on moderately granulate surface; metasoma with T3-7 brownish red except for fuscous of basal 0.3 of T3 . . . . . *nigriscapus*

— Mesopleurum with punctures separated by 0.3-0.5 their diameter on weakly granulate or smooth surface; metasoma with T3, plus midlines and portions of dorsal lateral areas of T4-7, fuscous, with remainder of metasoma brownish red . . . . . *macilenta*

3. Pronotum with upper corner of lateral area strongly granulate with punctures either absent or sparse; T2-7 dark brown-fuscous except for brownish red apex of T2 and occasionally all of T4; length 4.0-6.1 mm 4

— Pronotum with upper corner of lateral area rugosopunctate or closely punctate on smooth or granulate surface; T2-7 usually with more extensive areas of brownish red; length usually larger than above range . . . 5

4. Areolet absent; T4 brownish red; gonoforceps and S9 as in fig. 26e-f . . . . . *anareolata*

— Areolet present; T4 dark brown-fuscous; gonoforceps and S9 as in figs. 25n-o, 27g-h, 29a-b, 29c-d, & 29g-h . . *amplareolata, australis, eremna, marjoriella,* and *masoni*

5. Propodeum with only basal transverse, pleural, and parts of apical transverse carinae present, surface uniformly covered by strong punctures on granulate surface; S9 as in fig. 28i . . . . . *punctata*

— Propodeum with full complement of carinae, surface not uniformly punctate 6

6. Pronotum with upper corner of lateral area having regular shallow punctures on strongly granulate surface, appearing shagreened (figs. 1b-c) 7

— Pronotum with upper corner rugosopunctate or closely punctate, on smooth or (usually) weakly granulate surface 9

7. Propodeum with areola as long as wide or somewhat elongate (similar to fig. 17k); hind leg with trochanters dark brown-fuscous; gonoforceps and S9 as in figs. 26g-h . . . . . *micraulax*

— Propodeum with areola elongate; hind leg with trochanters dark brown-fuscous, or second trochanter whitish yellow; gonoforceps and S9 otherwise (figs. 25l-m & 29e-f) 8

8. Propodeum with central area similar to fig. 17f; hind leg with coxa and trochanters dark brown-fuscous; gonoforceps and S9 as in figs. 29e-f . . . . . *erythropus*

— Propodeum with central area similar to fig. 17h; hind leg with apical 0.3 of coxa, and all of second trochanter, whitish yellow; gonoforceps and S9 as in figs. 25l-m . . . . . *platyura*

9. Coxae completely dark brown-fuscous; middle and hind femora dark brown 10

— Not as above 11

10. Middle and hind legs dark brown; S9 as in fig. 28f. . . . . *nigricoxalis*

— Middle and hind legs with trochanters whitish yellow except for dark brown of first hind trochanter and brownish red tibiae; brownish red; S9 as in fig. 25e . . . . . *fuscifemorata*

11. Pronotum with upper corner having strong punctures concentrated along margins, separated by about 0.3 their diameter or contiguous, on granulate surface; propodeal carinae similar to fig. 18a; gonoforceps and S9 as in figs. 25h-i. . . . . *daschi*

— Pronotum with upper corner uniformly rugosopunctate or closely punctate, on smooth surface; otherwise not as above 12

12. Metasoma completely fuscous; propodeal carinae similar to fig. 16d; gonoforceps and S9 as in figs. 27a-d . . . . . *scitula*

— Metasoma with brownish red areas

on T2-7; otherwise not as above 13

13. Mesopleurum with scrobe not a distinct pit; mesopleural suture with transverse rugae weak or absent; propodeal carinae not as high or strong as usual for males, similar to fig. 17c; S9 as in fig. 27f . . . . *sculleni*
— Mesopleurum with scrobe a distinct pit; mesopleural suture with transverse rugae present and strong; otherwise not as above 14
14. Metasoma with postpetiole and T2-7 brownish red; propodeal carinae as in fig. 16c; gonoforceps and S9 similar to figs. 28a-b . . . . . *erythrogaster*
— Metasoma with T2 completely, and areas of T3-7, fuscous; otherwise not as above 15
15. Propodeum with areola elongate and narrow, and juncture of areola-petiolar area moderately to strongly constricted (figs. 15i, 16f, & 18c) 16
— Propodeum with areola not so constricted, ranging from elongate to as long as wide 18
16. Gonoforceps with inner margins only shallowly emarginate (fig. 28g); S9 laterally angulate (fig. 28h) . . . . . *sokanakiakorum*
— Gonoforceps more deeply emarginate (figs. 25j & 26k); S9 laterally rounded (fig. 25k & 26l) 17
17. Propodeal carinae as in fig. 15i and not high and strong as is usual for males; propodeum with base of areola adjacent to basal margin; gonoforceps and S9 as in figs. 25j-k . . . . . *leptogaster*
— Propodeal carinae similar to fig. 16f and high and strong; propodeum with base of areola distant from basal margin; gonoforceps and S9 as in fig. 26k-l . . . . . *portalensis*
18. Propodeum with areola about as long as wide; pronotum with upper corner closely punctate; mesopleurum with punctures separated by about their diameter on weakly granulate surface; gonoforceps and S9 as in figs. 26a-d . . . . . *finlaysonae* and *hadra*
— Propodeum with areola ranging from about as long as wide to elongate; pronotum with upper corner rugosopunctate; mesopleurum with punctures either closer together or on strongly granulate surface 19
19. Propodeum with areola elongate, similar to fig. 17h; pronotum with upper corner of lateral area rugosopunctate on granulate surface; hind coxae with apical 0.3 whitish yellow; gonoforceps and S9 as in figs. 25l-m . . . . . *platyura*
— Propodeum with areola shorter or narrower; pronotum with surface of upper corner not granulate; otherwise not as above 20
20. FMS with postpetiole brownish red; metasoma with basal 0.3 of T2 fuscous, remainder brownish red; mesopleural surface weakly granulate; gonoforceps and S9 as in figs. 25f-g . . . . . *licina*
— FMS with postpetiole dark brown-fuscous; metasoma with basal 0.8-0.9 of T2 fuscous-dark brown; mesopleural surface weakly-moderately granulate 21
21. Propodeum with areola somewhat elongate (fig. 17i); S9 as in fig. 26j . . . . . *longicuspis*
— Propodea with areola elongate (fig. 18k); S9 as in fig. 28d . . . . *floridensis*

DESCRIPTIONS OF SPECIES

Venturia amplareolata, new species
(figs. 13g, 15d, 20a-b, 22f, 29c-d)

DIAGNOSIS. Similar to other small species with roundish heads, parallel inner ventral margins of the compound eyes, and sparsely punctate pronotal upper corners; it can be recognized by the yellow fore and middle coxae, dark brown hind femur and tibia, unusually large areola with a granulate surface, high postpetiole, and brownish red T4-7 except for the fuscous midlines.

FEMALE. *Structure:* 1. Malar space about 0.5 as long as basal mandibular width. 2. Antenna with 30 flagellomeres. 3. Frontal and dorsal outlines of head as in fig. 20a-b; OOD about 0.8. 4. Genal width about 0.4. 5. Mesosomal profile as in fig. 22f; mesonotal profile strongly

produced; subalar ridge weakly rugosopunctate. 6. Pronotum with epomia strong; lateral area with weak rugae on granulate surface; upper corner with weak punctures separated by 0.3-0.5 their diameter, on strongly granulate surface. 7. Mesopleurum with punctures in central region immediately below hypoepimeron about 0.1 OD, separated by 0.5-1.0 their diameter, on strongly granulate surface; scrobal groove with low rugae from subalar ridge halfway to scrobe; hypoepimeron with punctures only on dorsal margin. 8. Propodeum with areola elongate and relatively large in relation to rest of propodeum, juncture of areola-petiolar area moderately constricted (fig. 15d); areola granulate, petiolar area with complete transverse rugae only on apical 0.5; first and second lateral areas with punctures weak or absent on granulate surface; propodeal neck about 0.6 as long as wide. 9. Hind femur about 4.7 as long as wide; hind tibial spur about 0.5 as long as hind basitarsus. 10. Areolet petiolate, stalk about 0.5 as long as cell. 11. FMS with petiole about 1.7 as long as postpetiole (fig. 13g). 12. T2 about 2.3 as long as apical width; metasoma moderately compressed. 13. Ovipositor about 3.1 as long as hind femur, moderately curved. *Color:* Head and mesosoma black, the following whitish yellow: mandible except for brown of base and apex, palpi, scape and pedicel ventrally, tegula, apical 0.2 of fore and middle coxae, trochanters except for brown posterior face of first hind trochanter, and dorsal basal spot of hind tibia. Fore and middle coxae otherwise brownish yellow. Remainder of fore and middle legs brownish red. Remainder of hind leg dark brown except for brownish yellow of basal 0.3 of basitarsus. FMS black except for piceous apical 0.5 of postpetiole. Basal 0.8 of T2, basal 0.5 and midline of T3, and midlines of remaining terga, fuscous; remainder of metasoma brownish red. *Length:* 6.0 mm; wing 3.4 mm; ovipositor 3.6 mm.

MALE. *Structure:* Similar to female except genal width 0.5; propodeum with central area narrower, carinae higher and stronger; right gonoforceps and S9 as in figs. 29c-d. *Color:* Similar to female except that basal 0.3 of fore coxa and basal 0.8 of middle coxa dark brown; first hind trochanter completely dark brown; T3-7 dark brown except for brownish red apical spot on midline of T6; gonoforceps dark brown. *Length:* 5.0 mm; wing 2.9 mm.

TYPE MATERIAL. Female holotype [HMTC], *MEXICO—Oaxaca:* 6 mi. S. Valle Nacional, 20 May 1971, 2000 ft., H. Howden. Paratype, 1M HMTC, same data as for holotype except collected 18 May 1971.

COMMENT. Valle Nacional is about 90 km N-NE of Oaxaca (city).

ETYMOLOGY. From the Latin *amplus,* large, and *areola,* an open space, in reference to the disportionately large areola.

Venturia anareolata, new species
(figs. 13b, 15h, 19q-r, 22g, 26e-f)

DIAGNOSIS. This species can be distinguished from other species in the Gelechiae Group by the narrow (0.3) gena, yellow fore and middle coxae, lack of an areolet, slender FMS with depressed postpetiole, fuscous metasoma except for brownish red areas of lower lateral 0.5 of T4-7, and ovipositor about 2.0 as long as the hind femur.

FEMALE. *Structure:* 1. Malar space about 0.3 as long as basal mandibular width. 2. Antenna with 29-30 flagellomeres. 3. Frontal and dorsal outlines of head as in fig. 19q-r; eyes ventrally convergent; OOD about 0.6. 4. Genal width about 0.3. 5. Mesosomal profile as in fig. 22g; mesonotal profile strongly produced; subalar ridge punctate. 6. Pronotum with epomia strong; lateral area with strong rugae except where obsolescent adjacent to front edge, on smooth surface; collar weakly granulate and impunctate; upper corner with sparse punctures on granulate surface. 7. Mesopleurum with punctures in central region immediately below hypoepimeron about 0.1 OD, separated by 0.3-1.0 their diameter, on weakly granulate surface; scrobal groove with strong rugae extending from subalar ridge to near scrobe; hypoepimeron with punctures present on dorsal margin, sparse or absent on posterior margin. 8. Propodeum with areola about as long as wide, juncture of areola-petiolar area moderately constricted (fig. 15h); areola strongly granulate, petiolar area with fine transverse rugae; first lateral area with regular punctation on granulate surface, second lateral area weakly rugosopunctate on granulate surface; propodeal neck about 0.6 as long as wide. 9. Hind femur about 4.7 as long as wide; hind tibial spur about 0.5 as long as hind basitarsus. 10. Areolet absent. 11. FMS with petiole about 1.7 as long as postpetiole, postpetiole depressed (fig. 13b). 12. T2 about 2.1 as long as apical width; metasoma moderately compressed. 13. Ovipositor about 2.0 as long as hind femur, weakly curved. *Color:* Head and mesosoma black, the following whitish yellow: mandible except for brown of base and apex, palpi, scape and pedicel ventrally, tegula, fore and middle coxae either completely or fore coxa with apical

0.5 and middle coxa with apical 0.3, extreme apex of hind coxa, trochanters except for brown of posterior face of first hind trochanter, dorsal surfaces of fore and middle tibia, and dorsal basal spot on hind tibia. Fore and middle legs otherwise brownish red. Coxae otherwise dark brown-fuscous. Remainder of hind leg brown, except for lighter areas on median of posterior face of femur, and median 0.3 of tibia. FMS black, except for deep brownish red extreme apex of postpetiole. Basal 0.9 of T2, and midlines and upper 0.5 of lateral areas of T3-7, fuscous. Metasoma otherwise brownish red. *Length:* 5.5-6.0 mm (5.6 mm); wing 2.8-3.0 mm (2.8 mm); ovipositor 1.9-2.1 mm (2.1 mm).

MALE. *Structure:* Similar to female except eyes not ventrally convergent; genal width 0.5; propodeum with central area narrower and carinae higher and stronger; right gonoforceps and S9 as in figs. 26e-f. *Color:* Similar to female, T3-7 dark brown except for brownish red of T4 and ventral 0.5 of lateral area of T4; gonoforceps fuscous. *Length:* 5.8-6.1 mm; wing 2.8-3.1 mm.

TYPE MATERIAL. Female holotype [HMTC], *UNITED STATES—Texas:* "Big Bend" (presumably Big Bend National Park, Brewster Co.), 1 Aug. 1975, 5000 ft., S. & J. Peck. Paratypes, *MEXICO—Nuevo Leon:* 1F [CNCI], 5 mi. S. Monterrey, 19 July 1965, H.F. Howden; *UNITED STATES—Arizona:* 1F [HMTC], Coconino Co., Oak Creek Canyon, 18 May 1947, H. & M. Townes; *Texas:* 2FF and 1M [TAMU], 1F [DBWC], Starr Co., Falcon State Park, 10 June 1969, V.V. Board; 1M [TAMU], 1M [DBWC], same data except collected 18 May 1978 by C. Porter and A. Cerbone.

COMMENT. A female specimen from Mexico (*Veracruz:* Minatitlan, 26 Aug.-1 Sept. 1961, R.R. Dreisbach [MSUC]) seems to belong to this species, except that the ovipositor is about 3.3 times as long as the hind femur.

ETYMOLOGY. From the Latin *an-*, without, and *areolet*, in reference to the lack of an areolet.

Venturia anchisteus, new species
(figs. 13u, 18d, 20m-n, 24k)

DIAGNOSIS. Distinguished from other species in the Nigriscapus Group by the wide (0.5) and flat gena, fuscous fore and middle coxae, interception of the postnervulus at the anterior 0.3, nervulus opposite the basal vein, rugosopunctate metapleurum, pattern of the central area of the propodeum (fig. 18d), and moderately compressed metasoma.

FEMALE. *Structure:* 1. Malar space about 0.3 as long as basal mandibular width. 2. Antenna with 44 flagellomeres (only one specimen with complete flagellum). 3. Frontal and dorsal outlines of head as in fig. 20m-n; OOD about 1.0. 4. Genal width about 0.5. 5. Mesosomal profile as in fig. 24k; mesonotal profile strongly produced; subalar ridge weakly rugosopunctate. 6. Pronotum with epomia strong; lateral area with strong rugae on smooth surface; upper corner rugosopunctate, punctures separated by about 0.3 their diameter. 7. Mesopleurum with punctures in central region immediately below hypoepimeron about 0.2 OD, shallow and separated by about 0.5 their diameter, on moderately granulate surface; scrobal groove with strong rugae from subalar ridge to near scrobe; hypoepimeron with close punctures on dorsal and upper 0.5 of posterior margins. 8. Propodeum with areola elongate, juncture of areola-petiolar area moderately constricted (fig. 18d); areola with transverse rugae on smooth surface, petiolar area with strong transverse rugae; first lateral area weakly rugosopunctate, second lateral area rugosopunctate; propodeal neck about 0.5 as long as wide. 9. Hind femur about 5.5 as long as wide; hind tibial spur about 0.5 as long as hind basitarsus. 10. Areolet petiolate, stalk about 0.2 as long as cell. 11. FMS with petiole about 1.8 as long as postpetiole, postpetiole high (fig. 13u). 12. T2 about 2.6 as long as apical width; metasoma strongly compressed. 13. Ovipositor 2.0-2.1 as long as hind femur, almost straight. *Color:* Head and mesosoma black, the following whitish yellow: mandible except for brown of base and apex, palpi, scape and pedicel except for brown dorsum, tegula, apical 0.3 of fore coxa and extreme apex of middle coxa, trochanters except brown dorsum of first hind trochanter, and dorsal basal spot of hind tibia. Coxae otherwise fuscous. Remainder of fore and middle legs brownish yellow. Hind femur brownish red; hind tibia and tarsi dark brown. FMS with petiole black, postpetiole deep brownish-red. Basal 0.4-0.5 of T2, basal 0.3 and midline of T3, fuscous; metasoma otherwise brownish red. *Length:* 8.9-9.1 mm (10.1 mm); wing 4.6-4.9 mm (5.3 mm); ovipositor 3.4-3.7 mm (4.0 mm).

TYPE MATERIAL. Female holotype [SEMC], *MEXICO—Morelos:* 7.3 mi. S. Yautepec, 3000 ft., 16 Aug. 1962, E. Ordway & M. Naumann. Paratypes, *MEXICO—Mexico:* 1F [MSUC], Tequesquitengo, 15 July 1961, R. & K. Dreisbach; *San Luis Potosí:* 1F [MSUC], "Valles" (prob. Ciudad de Valles), 8 Aug. 1954, R.R. Dreisbach.

ETYMOLOGY. From the Greek *anchisteus*,

next of kin, in reference to the close relationship of this species to *nigriscapus* and its relatives. It is a noun in apposition.

Venturia australis, new species
(figs. 13h, 14v, 19i-j, 22j, 27g-h)

DIAGNOSIS. Similar to other small species with roundish heads, parallel inner ventral margins of the compound eyes, and sparsely punctate pronotal upper corners; it can be distinguished by the wide gena (0.5), fuscous coxae and metasoma, light brownish red hind femur, somewhat elongate areola, strongly constricted juncture of the areola-petiolar area, and the ovipositor being 2.3-2.6 as long as the hind femur.

FEMALE. *Structure:* 1. Malar space about 0.4 as long as basal mandibular width. 2. Antenna with 25-26 flagellomeres. 3. Frontal and dorsal outlines of head as in fig. 19i-j; OOD about 1.0. 4. Genal width about 0.5. 5. Mesosomal profile as in fig. 22j; mesonotal profile strongly produced; subalar ridge weakly rugosopunctate. 6. Pronotum with epomia strong; lateral area with strong rugae on weakly granulate surface; upper corner with scattered punctures on strongly granulate surface. 7. Mesopleurum with punctures in central region immediately below hypoepimeron about 0.1 OD, separated by 0.5-1.0 their diameter on strongly granulate surface; scrobal groove with strong rugae extending from subalar ridge to near scrobe; hypoepimeron with punctures absent or sparse on dorsal and posterior margins. 8. Propodeum with areola somewhat elongate, juncture of areola-petiolar area strongly constricted (fig. 14v); areola with strongly granulate surface, petiolar area with fine transverse rugae; first and second lateral areas with scattered shallow punctation on granulate surface; propodeal neck about 0.5 as long as wide. 9. Hind femur about 4.6 as long as wide; hind tibial spur about 0.5 as long as hind basitarsus. 10. Areolet petiolate, stalk about 0.4 as long as cell. 11. FMS with petiole about 1.6 as long as postpetiole (fig. 13h). 12. T2 about 2.0 as long as apical width; metasoma moderately compressed. 13. Ovipositor 2.3-2.6 as long as hind femur, weakly curved. *Color:* Head and mesosoma black, the following whitish yellow: mandible except for brown of base and apex, palpi, scape ventrally, tegula, apical 0.3 of fore and middle coxae, trochanters except for brownish first hind trochanter, and dorsal basal spot of hind tibia. Fore and middle legs brownish red. Coxae otherwise dark brown-fuscous. Hind femur brownish red except for dark brown of apical 0.1; hind tibia and tarsi brown, except for brownish red of median 0.3 of tibia and basal 0.8 of basitarsus. FMS black except for piceous 0.3 of postpetiole. Apical 0.2 of T2 brownish red; remainder of metasoma dark brown-fuscous. *Length:* 4.1-4.5 mm (4.2 mm); wing 2.6-2.7 mm (2.7 mm); ovipositor 1.9-2.1 mm (1.9 mm).

MALE. *Structure:* Similar to female except genal width 0.5; propodeum with central area narrower, carinae stronger and higher; postpetiole depressed; right gonoforceps and S9 as in figs. 27g-h. *Color:* Similar to female except first hind trochanter and hind femur dark brown; gonoforceps fuscous. *Length:* 4.4-4.5 mm; wing 2.6-2.7 mm.

TYPE MATERIAL. Female holotype [USNM], *UNITED STATES—Louisiana:* St. Andry Parish, G. R. Pilate. Paratypes, *UNITED STATES—Kansas:* 1F [DBWC], Douglas Co., 4 mi. N. Lawrence, 3 Sept. 1979, D.B. Wahl; *Louisiana:* 2FF [USNM], same data as for holotype; *Texas:* 1F [OSUO], Brazos Co., College Station, 17 May 1936, "student col."; 1M [HMTC], Denton Co., Roanoke, 31 May 1951, H.E. Evans; 1M [SEMC], Jeff Davis Co., Davis Mountains, 17 April 1954, L.D. Beamer; 1F [USNM], Victoria Co., Victoria, 25 Sept. 1906, J.C. Crawford.

COMMENT. In females, the first hind trochanter usually has the anterior face lighter than the posterior.

ETYMOLOGY. From the Latin *australis*, southern, in reference to the distribution of this species in the southern areas of the United States.

Venturia brachypropodealis, new species
(figs. 13q, 16e, 21y)

Venturia sp. E, Finlayson, 1975. Mem. Entomol. Soc. Canada 94: 24.

DIAGNOSIS. This species can be distinguished from others in the Hadra Group by the dark brown-fuscous first hind trochanter, somewhat elongate areola with the surface smooth and with weak rugae, strongly granulate mesopleurum, brownish red metasoma with fuscous markings confined to the petiole, and length (7.7-8.0 mm).

FEMALE. *Structure:* 1. Malar space about 0.4 as long as basal mandibular width. 2. Antenna with 37-38 flagellomeres. 3. Frontal outline of head similar to fig. 20o, dorsal outline of head as in fig. 21y; OOD about 0.8. 4. Genal width about 0.4. 5. Mesosomal profile similar to fig. 23g; mesonotal profile somewhat produced; mesosoma stout, propodeum short; subalar

ridge weakly rugosopunctate. 6. Pronotum with epomia strong; lateral area with rugae rather weak, on smooth surface; upper corner punctate, punctures separated by about 0.3 their diameter on smooth surface. 7. Mesopleurum with punctures in central region immediately below hypoepimeron about 0.1 OD, separated by 0.3-0.5 their diameter, on strongly granulate surface; scrobal groove with strong rugae extending from subalar ridge to scrobe; hypoepimeron with punctures sparse on posterior margin, more abundant on dorsal margin. 8. Propodeum with areola somewhat elongate, juncture of areola-petiolar area weakly constricted (fig. 16e); areola with weak transverse rugae on smooth surface, petiolar area with rugae transverse centrally, reticulate adjacent to median longitudinal carinae; first lateral area with scattered punctures on granulate surface, second lateral area centrally with coarse punctures on granulate surface and rugulose adjacent to margins; propodeal neck about 0.3 as long as wide. 9. Hind femur about 5.0 as long as wide; hind tibial spur about 0.5 as long as hind basitarsus. 10. Areolet petiolate, stalk about 0.2 as long as cell. 11. FMS with petiole about 1.8 as long as postpetiole (fig. 13q). 12. T2 about 1.2 as long as apical width; metasoma weakly compressed. 13. Ovipositor 2.3-2.4 as long as hind femur, moderately curved. *Color:* Head and mesosoma black, the following whitish yellow: mandible except for brown of base and apex, palpi, ventral surfaces of scape and pedicel, tegula, apical 0.8 of fore coxa and apical 0.5 of middle coxa, fore and middle trochanters, and dorsal edge of front tibia. Remainder of fore and midddle coxae dark brown. Remainder of fore and middle legs light brownish red. Hind leg with coxa fuscous, first trochanter dark brown, and remainder of leg brownish red. Metasoma with basal 0.9 of petiole and extreme base of T2, black; remainder brownish red. *Length:* 8.0 mm (7.7 mm); wing 4.9 mm (5.1 mm); ovipositor 4.4 mm (3.6 mm).

TYPE MATERIAL. Female holotype [HMTC], *UNITED STATES—Nebraska:* Cherry Co., Valentine National Wildlife Refuge, 7 June 1972, H. & M. Townes. Paratype, *CANADA—Quebec:* 1F [CNCI], Laval, emerged 24 Feb. 1941, "R.I.W. 40; 6970-B; ex Tortricidae".

ETYMOLOGY. From the Greek *brachys,* short, and *propodeum,* in reference to the short propodeum of this species.

Venturia canescens (Gravenhorst)

(figs. 1e, 2d, 3d, 14p, 17a, 21w, 23m)

Campoplex canescens Gravenhorst, 1829. Ichneumonologia Europaea, vol.3, p. 555. Male (Wroclaw; type not examined).

Cryptus ductilus Say, 1836. Boston J. Nat. Hist. 1: 233.

Campoplex frumentarius Rondani, 1877. Bull. Soc. Entomol. Italia 9: 169.

Nemeritis gracilis Tosquinet, 1896. Mem. Soc. Entomol. Belgique 5: 414.

Omorga columbia Ashmead, 1899. *In* Johnson, Bull. United States Dept. Agric., Div. Entomol. 20: 67.

Idechthis oahuensis Ashmead, 1901. Fauna Hawaiiensis, vol. 1, p. 355.

Lathrostizus insularis Ashmead, 1901. Fauna Hawaiiensis, vol. 1, p. 355.

Idechthis ephestiae Ashmead, 1903. *In* Fletcher, Ann. Rpt. Entomol. Soc. Ontario 33: 86.

Limnerium garrulum Cameron, 1905. Rec. Albany Mus. 1: 315.

Amorphota ephestia Froggatt, 1912 (April). Agric. Gaz. New South Wales 23: 209.

Amorphota ephestiae Cameron, 1912 (August). Proc. Linn. Soc. New South Wales 37(1): 187.

Mesochorus australicus Girault, 1925. Queensland Agric. J. 24: 541.

Limnerium christianae Cheesman, 1928. Ann. Mag. Nat. Hist. (10)1: 191.

Angitia pyraustae Uchida, 1930. Insecta Matsumurana 4: 129.

Angitia compressa Hedwig, 1962. Nachr. Nat.-Mus. Aschaffenburg 68: 94.

DIAGNOSIS. This species can be recognized by the narrow (0.3) gena, rugosopunctate pronotal upper corner, punctate subalar ridge, elongate mesopleurum, yellow fore and middle coxae, brown or yellow hind trochanters, deep brownish red to dark brown hind femur, elongate narrow areola distant from the basal propodeal margin, low postpetiole, and brownish red T4-7 except for the fuscous midlines.

FEMALE. *Structure:* 1. Malar space about 0.3 as long as basal mandibular width. 2. Antenna with 35-38 flagellomeres. 3. Frontal outline of head similar to fig. 20o, dorsal outline as in fig. 21w; OOD about 0.6. 4. Genal width about 0.3. 5. Mesosomal profile as in fig. 23m; mesonotal profile somewhat produced; subalar ridge punctate. 6. Pronotum with strong epomia; lateral area with strong rugae extending to lower corner, on smooth surface; upper corner rugosopunctate, punctures separated by about 0.3 their diameter. 7. Mesopleurum with punctures in central region immediately below hypoepimeron about 0.1 OD, separated by 0.3-0.5 their diameter, on weakly to moderately granulate surface; scrobal groove with strong rugae halfway to scrobe; hypoepimeron with close

punctures on dorsal and posterior margins. 8. Propodeum with areola elongate, juncture of areola-petiolar area weakly constricted (fig. 17a); areola with fine transverse rugae on granulate surface, petiolar area with strong transverse rugae; first lateral area densely punctate on weakly granulate surface, second lateral area rugosopunctate on granulate surface; propodeal neck about 0.6 as long as wide. 9. Hind femur about 5.2 as long as wide; hind tibial spur about 0.5 as long as hind basitarsus. 10. Areolet petiolate, stalk about 0.3 as long as cell. 11. FMS with petiole about 1.6 as long as postpetiole (fig. 14p). 12. T2 about 2.1 as long as apical width; metasoma moderately compressed. 13. Ovipositor 2.8-3.1 as long as hind femur, moderately curved. *Color:* Head and mesosoma black, the following whitish yellow: mandible except dark brown of base and apex, ventral surfaces of scape and pedicel, palpi, fore and middle coxae except for dark brown of extreme base, fore and middle trochanters, and tegula. Remainder of fore and hind legs light brownish red. Hind leg varying from completely dark brown except for whitish yellow of second trochanter, to having trochanters yellow with dorsum of first trochanter brown, femur and tibia brownish red, with basal 0.3 of femur and sub-basal and apical bands of tibia slightly darker. FMS black with postpetiole deep brownish red. T2, basal 0.5 of T3, and at least midlines and usually part of upper lateral areas of T4-8, ranging from fuscous to brown; remainder of metasoma light brownish red. *Length:* 5.0-9.0 mm; wing 3.2-5.1 mm; ovipositor 3.2-5.2 mm.

MALE. Based upon examination of one male [HMTC] from France (*Bouches-du-Rhone:* La Ciotat, 28 July 1963, J.F. Aubert) and eight males [CISC] from an insectary culture of *Ectomyelois ceratoniae* from Spain (*Alicante:* Denia, Sept. 1966). *Structure:* Similar to female, antenna with 32 flagellomeres; genal width 0.4; propodeum with carinae stronger and higher. *Color:* Similar to female, second hind trochanter ranging from brown to completely yellow, hind femur brownish red with base and apex slightly darker; hind tibia dorsally, and hind tarsi, dark brown; FMS black; T2-3, and midlines and upper lateral areas of T4-7, dark brown; gonoforceps brown; remainder of metasoma brownish red.

SPECIMENS EXAMINED. 678 females and nine males.

DISTRIBUTION. Found throughout the Nearctic, usually as a parasitoid of caterpillars feeding on stored products in warehouses and similar situations. It also attacks hosts outdoors; see below.

COMMENT. Some specimens have the normally fuscous markings of the hind coxa, FMS, and terga dark brown with only with the basal part of the petiole fuscous. One specimen had the normally black head and mesosoma deep brownish red.

Three specimens were caught in a Malaise trap at New Concord, Ohio [CEDC], and Carlson (1979) reports the record of *canescens* being reared from a species of *Ephestia* in a bumblebee nest. Salt (1975) reviewed the literature on the hosts of *canescens* and concluded that the wasp can find and attack hosts outdoors. Pyralidae seem to be especially susceptible to parasitization. According to Carlson (1979), naturally occurring males of *canescens* are unknown in the Nearctic, found occasionally in Europe, and are more common in the Mediterranean area.

Venturia capulata, new species
(figs. 14f, 15l, 21a-b, 24f)

DIAGNOSIS. This species can be distinguished from others with roundish heads, parallel inner ventral margins of the compound eyes, and sparsely punctate pronotal upper corners by the predominantly yellow fore and middle coxae, light brownish red hind femur, shape of the areola (fig. 15l), and brownish red T4-7 except for the fuscous midlines.

FEMALE. *Structure:* 1. Malar space about 0.3 as long as basal mandibular width. 2. Antenna with 32 flagellomeres (only one specimen with complete flagellum). 3. Frontal and dorsal outlines of head as in fig. 21a-b; OOD about 1.0. 4. Genal width about 0.3. 5. Mesosomal profile as in fig. 24f; mesonotal profile strongly produced; subalar ridge punctate. 6. Pronotum with epomia strong; lateral area with strong rugae on smooth surface; upper corner with scattered punctures on weakly granulate surface. 7. Mesopleurum with punctures in central region immediately below hypoepimeron about 0.1 OD, separated by 0.3-0.5 their diameter, on weakly granulate surface; scrobal groove with strong rugae extending from subalar ridge to scrobe; hypoepimeron with sparse punctures on dorsal and posterior surfaces. 8. Propodeum with areola elongate, juncture of areola-petiolar area moderately constricted (fig. 15l); areola with granulate surface, petiolar area reticulostriate; first lateral area with sparse punctures on granulate surface, second lateral area weakly rugosopunctate on granulate surface; propodeal neck about 0.6 as long as wide. 9. Hind femur about 5.0 as long as wide; hind tibial spur about 0.5 as long as hind basitarsus.

10. Areolet petiolate, stalk about 0.4 as long as cell. 11. FMS with petiole about 1.5 as long as postpetiole (fig. 14f). 12. T2 about 2.1 as long as apical width; metasoma moderately compressed. 13. Ovipositor 2.6-2.8 as long as hind femur, weakly curved. *Color:* Head and mesosoma black, the following whitish yellow: mandible except for brown of base and apex, palpi, scape ventrally, tegula, apical 0.7 of fore and apical 0.3 of middle coxae, extreme apex of hind coxa, trochanters, dorsal surface of fore tibia, and dorsal basal spot of hind tibia. Remainder of fore and middle coxae dark brown. Hind coxa otherwise fuscous. Remainder of fore and middle legs brownish red. Hind tibia brown except for yellowish brown ventral median stripe. FMS with petiole black, postpetiole dark brown-fuscous with extreme apex lighter. Basal 0.8 of T2, basal 0.6 and midline of T3, and midlines of T4-7, dark brown-fuscous; remainder of metasoma brownish red. *Length:* 6.9 mm (6.6 mm); wing 3.8 (3.8 mm); ovipositor 3.2 mm (3.1 mm).

TYPE MATERIAL. Female holotype [HMTC], *UNITED STATES—Texas:* Culberson Co., McKittrick Canyon, 5200 ft., 15 Aug. 1961, F. & N. Gehlbach. Paratype [HMTC], same data as holotype, except collected 19 Aug. 1961.

ETYMOLOGY. From the Latin *capulus,* coffin, in reference to the shape of the areola, which resembles an old-fashioned coffin.

Venturia chnaura, new species
(figs. 13k, 15b, 19a-b, 22k)

DIAGNOSIS. Distinguishable from other species in the Gelechiae Group by the low pronotal rugae, yellow fore and middle coxae, light brownish red hind femur, elongate areola near the basal propodeal margin, and fuscous metasoma.

FEMALE. *Structure:* 1. Malar space about 0.3 as long as basal mandibular width. 2. Antenna with 31 flagellomeres. 3. Frontal and dorsal outlines of head as in fig. 19a-b; eyes ventrally convergent; OOD about 0.9. 4. Genal width about 0.3. 5. Mesosomal profile as in fig. 22k; mesonotal profile strongly produced; subalar ridge weakly rugosopunctate. 6. Pronotum with epomia strong; lateral area with weak rugae on smooth surface; upper corner with scattered punctures on strongly granulate surface; collar smooth. 7. Mesopleurum with punctures in central region immediately below hypoepimeron about 0.1 OD, separated by 0.5-1.0 their diameter, on strongly granulate surface; mesopleural suture with transverse rugae absent except near dorsal end; scrobal groove with strong rugae extending from subalar ridge halfway to scrobe; hypoepimeron with punctures absent on dorsal and posterior margins. 8. Propodeum with areola elongate, juncture of areola-petiolar area moderately constricted (fig. 15b); areola with scattered punctures on granulate surface, petiolar area with fine reticulate rugae; first and second lateral areas with scattered punctures on granulate surface; propodeal neck about 0.5 as long as wide. 9. Hind femur about 5.2 as long as wide; hind tibial spur about 0.5 as long as hind basitarsus. 10. Areolet petiolate, stalk about 0.6 as long as cell. 11. FMS with petiole about 1.5 as long as postpetiole, postpetiole high (fig. 13k). 12. T2 about 1.9 as long as apical width; metasoma moderately compressed. 13. Ovipositor about 2.6 as long as hind femur, weakly curved. *Color:* Head and mesosoma black, the following whitish yellow: mandible except for brown of base and apex, palpi, scape and pedicel ventrally, tegula, fore and middle coxae except for brown of extreme base, apical 0.2 of hind coxa, trochanters, and dorsal basal spot of hind tibia. Remainder of hind coxa dark brown-fuscous. Legs otherwise light brownish red, except for brown of sub-basal and apical parts of hind tibia, and apices of hind tarsomeres. FMS with petiole piceous; postpetiole deep reddish brown except for brownish red of apical 0.3. Apical 0.2 of T2, and scattered spots on lateral areas of T6-7, brownish red; metasoma otherwise dark brown. *Length:* 5.5 mm; wing 3.1 mm; ovipositor 3.4 mm.

TYPE MATERIAL. Female holotype [USNM], *UNITED STATES—Arkansas:* Washington Co., "ad. 7-25-42; reared from red bud leaf roller."

ETYMOLOGY. From the Greek *chnauros,* dainty, in reference to the overall appearance of the insect.

Venturia compacta, new species
(figs. 13t, 18b, 20k-l, 24m)

DIAGNOSIS. This species can be distinguished from others in the Nigriscapus Group by the interception of the postnervulus at the midlength, nervulus opposite the basal vein, compact mesosoma (fig. 24m), predominately fuscous fore and middle coxae, punctate metapleurum, moderately compressed metasoma, and straight ovipositor with the apex slightly upcurved.

FEMALE. *Structure:* 1. Malar space about 0.5 as long as basal mandibular width. 2. Antenna with 31-33 flagellomeres. 3. Frontal and dorsal

outlines of head as in fig. 20k-l; OOD about 0.9. 4. Genal width about 0.4. 5. Mesosomal profile as in fig. 24m; mesonotal profile strongly produced; subalar ridge weakly rugosopunctate. 6. Pronotum with epomia strong; lateral area with strong rugae on smooth surface; upper corner rugosopunctate, punctures separated by about 0.3 their diameter, on smooth surface. 7. Mesopleurum with punctures in central region immediately below hypoepimeron about 0.2 OD, separated by 0.3-0.5 their diameter, on moderately granulate surface; scrobal groove with strong rugae extending from subalar ridge halfway to scrobe; hypoepimeron with punctures on dorsal and posterior margins, those on posterior margin sparse. 8. Propodeum with areola elongate, juncture of areola-petiolar area moderately constricted (fig. 18b); propodeal carinae rather weak; areola with transverse rugae on smooth surface, petiolar area with most rugae transverse but some reticulate; first lateral area with regular punctation on smooth surface, second lateral area rugosopunctate on smooth surface; propodeal neck about 0.6 as long as wide. 9. Hind femur about 4.8 as long as wide; hind tibial spur about 0.5 as long as hind basitarsus. 10. Areolet petiolate, stalk about 0.5 as long as cell. 11. FMS with petiole about 1.6 as long as postpetiole, postpetiole high (fig. 13t). 12. T2 about 2.4 as long as hind femur; metasoma moderately compressed. 13. Ovipositor 1.9-2.0 as long as hind femur, almost straight except for slight apical curve. *Color:* Head and mesosoma black, the following whitish yellow: mandible except for brown of base and apex, palpi, ventral surfaces of scape and pedicel, tegula, apical 0.3 of fore and middle coxae, extreme apex of hind coxa, trochanters, remainder of fore leg and dorsal surface of middle tibia, and basal dorsal spot and median dorsal patch of hind tibia. Coxae fuscous except as noted. Remainder of middle leg light brownish red. Remainder of hind leg dark brown except femur with median deep brownish red area. FMS fuscous except for deep brownish red of apical 0.2 of postpetiole. Basal 0.8 of T2, basal 0.5 and midlines of T3, and central portions of midlines of T4-6, fuscous; remainder of metasoma deep brownish red. *Length:* 7.5-8.6 mm (8.6 mm); wing 4.1-4.7 mm (4.6 mm); ovipositor 2.7-2.9 mm (2.9 mm).

TYPE MATERIAL. Female holotype [HMTC], *UNITED STATES—Arizona:* Cochise Co., Portal, 17 Aug. 1974, H. & M. Townes. Paratypes, 2FF [HMTC], 1F [DBWC], same data as for holotype except collected 14 and 17 Aug. 1974.

ETYMOLOGY. From the Latin *compacta,* thick or firm, in reference to the stout appearance of the mesosoma.

Venturia daschi, new species
(figs. 3b, 13y, 18a, 20o-p, 24h, 25h-i)

Venturia sp. C Finlayson, 1975. Mem. Entomol. Soc. Canada 94: 24.

DIAGNOSIS. Recognizable by the pronotal upper corner having the punctation concentrated along the margins on a granulate surface, fuscous 0.5 of fore and middle coxae, yellow hind trochanters, brownish red hind femur, elongate areola adjacent to the basal propodeal margin, granulate areola surface, elongate FMS with a low postpetiole, strongly compressed metasoma, and brownish red T4-7 except for the narrowly fuscous midlines.

FEMALE. *Structure:* 1. Malar space about 0.5 as long as basal mandibular width. 2. Antenna with 36-39 flagellomeres. 3. Frontal and dorsal outlines of head as in fig. 20o-p; OOD about 1.0. 4. Genal width about 0.4. 5. Mesosomal profile as in fig. 24h; mesonotal profile strongly produced; subalar ridge weakly rugosopunctate. 6. Pronotum with epomia strong; lateral area with weak rugae on smooth surface; upper corner rugosopunctate on granulate surface, punctures separated by about 0.3 their diameter and concentrated along margins. 7. Mesopleurum with punctures in central region immediately below hypoepimeron about 0.1 OD, separated by 0.5-1.0 their diameter, on weakly-moderately granulate surface; scrobal groove with weak rugae extending from subalar ridge halfway to scrobe; hypoepimeron with punctures sparse or absent on dorsal and posterior margins. 8. Propodeum with areola elongate, juncture of areola-petiolar area moderately constricted (fig. 18a); areola granulate with few transverse rugae, petiolar area basally reticulate, becoming transversely striate apically; first lateral area with regular shallow punctation on granulate surface, second lateral area rugosopunctate on granulate surface; propodeal neck about 0.6 as long as wide. 9. Hind femur about 5.3 as long as wide; hind tibial spur about 0.5 as long as hind basitarsus. 10. Areolet petiolate, stalk about 0.5 as long as cell. 11. FMS with petiole about 1.8 as long as postpetiole (fig. 13y). 12. T2 about 2.6 as long as apical width; metasoma strongly compressed. 13. Ovipositor 3.0-3.3 as long as hind femur, straight to slightly curved. *Color:* Head and mesosoma black, the following pale yellow: mandible except for brown of base and apex, ventral sur-

faces of scape and pedicel, palpi, tegula, apical 0.5 of fore coxa, apical 0.3 of middle coxa, apical 0.1 of hind coxa, and trochanters. Coxae otherwise dark brown-fuscous. Remainder of fore and middle legs light brownish red. Hind leg with femur brownish red, base and apex brown; tibia except for narrow brownish yellow basal band, and tarsi, brown. FMS varying from deep brownish red to black. T2 except for apical 0.2, basal 0.3 and midline of T3, and midlines of remaining terga, fuscous; remainder of metasoma brownish red. *Length:* 7.8-9.9 mm (9.3 mm); wing 4.1-5.4 mm (5.2 mm); ovipositor 4.8-5.9 mm (5.5 mm).

MALE. *Structure:* Similar to female, except genal width 0.5; propodeum with central area slightly narrower, carinae stronger and higher; right gonoforceps and S9 as in figs. 25h-i. *Color:* As in female, except basal 0.9 of T2, basal 0.5 of T3, midline of T4, upper lateral 0.5 of T5-6, and T7, fuscous; remainder of metasoma brownish red. *Length:* 9.0 mm; wing 4.7 mm.

TYPE MATERIAL. Female holotype [CEDC], *UNITED STATES—Ohio:* Muskingum Co., Ohio, 30 Aug. 1964, "trap", C. Dasch. Paratypes, *CANADA—Ontario:* 1F [CNCI], Utopia, "no. 046-1346c; 12 Feb. 1947; F.I.S.; ex tortricid"; 1F [CNCI], Chalk River, "no. 044-1370b; 9 Mar. 1945; F.I. Survey; ex *Stenoma*"; *UNITED STATES—Kansas:* 2FF [USNM], Riley Co., 2 Aug. and May, F. Marlatt; *Maryland:* 1F [HMTC], Montgomery Co., Takoma Park, 7 June 1942, H. & M. Townes; *Ohio:* 1F [CEDC], 1F [DBWC], same data as for holotype except collected 28 Aug. 1964 and 17-19 June 1975, "trap", C. Dasch.

OTHER SPECIMENS. *UNITED STATES—Georgia:* 1M [CNCI], Forsyth Co., Forsyth, 18-23, May 1970, "Malaise trap", F. Naumann.

COMMENT. Those specimens with a deep brownish red FMS have the metasomal markings brown, not fuscous; tergal midline markings in this case are discontinuous. Several specimens have the dark markings of the hind femur expanded and fuscous; the hind tibia and tarsi are also fuscous.

ETYMOLOGY. This species is named after Clement E. Dasch, in recognition of his noteworthy contributions to ichneumonid taxonomy.

Venturia dreisbachi, new species
(figs. 3f, 4a, 14d, 16h, 21m, 23b)

DIAGNOSIS. This species can be distinguished by the rugosopunctate pronotal upper corner, largely fuscous fore and middle coxae, brown first hind trochanter, elongate areola near the basal propodeal margin, granulate areolar surface with weak transverse rugae, dark brown metasoma except for the brownish red lower lateral 0.5 of T4-7, and strongly curved ovipositor with 2 dorsal nodi just before the apical notch.

FEMALE. *Structure:* 1. Malar space about 0.5 as long as basal mandibular width. 2. Antenna with 28-32 flagellomeres. 3. Frontal outline of head similar to fig. 20o, dorsal outline as in fig. 21m; OOD about 0.9. 4. Genal width about 0.4. 5. Mesosomal profile as in fig. 23b; mesonotal profile strongly produced; subalar ridge weakly rugosopunctate. 6. Pronotum with epomia strong; lateral area with weak rugae on granulate surface except where rugae absent adjacent to front edge; upper corner weakly rugosopunctate on granulate surface, punctures separated by 0.3-0.5 their diameter. 7. Mesopleurum with punctures in central region immediately below hypoepimeron about 0.1 OD, separated by 0.5-1.0 (occas. 0.3) their diameter, on moderately granulate surface; scrobal groove with strong rugae from subalar ridge halfway to scrobe; hypoepimeron with punctures on dorsal and posterior margins, those on posterior margin sparser. 8. Propodeum with areola elongate, juncture of areola-petiolar area strongly constricted (fig. 16h); areola granulate with weak transverse rugae, petiolar area with transverse rugae on weakly granulate-smooth surface; first lateral area with scattered shallow punctures on granulate surface, second lateral area rugosopunctate on granulate surface; propodeal neck about 0.6 as long as wide. 9. Hind femur about 5.4 as long as wide; hind tibial spur about 0.5 as long as hind basitarsus. 10. Areolet petiolate, stalk about 0.4 as long as cell. 11. FMS with petiole about 1.8 as long as postpetiole (fig. 14d). 12. T2 about 2.0 as long as apical width; metasoma moderately compressed. 13. Ovipositor 3.0-3.3 as long as hind femur, moderately curved; apex with two nodi before apical dorsal notch (fig. 4a). *Color:* Head and mesosoma black, the following whitish yellow: mandible except for brown of base and apex, palpi, scape ventrally, tegula, apical 0.3 of fore coxa and extreme apex of middle coxa, trochanters except for brown first hind trochanter, and dorsal basal spot of hind tibia. Coxae otherwise dark brown-fuscous. Remainder of fore and middle legs light brownish red. Hind femur brownish red, except for dark brown of basal and apical 0.3 of anterior face; hind tibia and tarsi brown, tibia darker basally and apically. FMS black; T2, T3 except for apical corners, and midlines and upper lateral areas of T4-7, fuscous; metasoma

otherwise brownish red. *Length:* 6.4-7.3 mm (7.0 mm); wing 4.1-4.6 mm (4.6 mm); ovipositor 4.1-4.6 mm (4.4 mm).

TYPE MATERIAL. Female holotype [MSUC], *MEXICO—Mexico:* Teotihuacan, 21 July 1956, R. & K. Dreisbach. Paratypes, 3FF [MSUC], 1F [DBWC], same data as for holotype.

ETYMOLOGY. This species is named after the late R.R. Dreisbach, a professional chemist who was a student and collector of Hymenoptera.

Venturia durangensis, new species
(figs. 4g, 14u, 18m, 21i-j, 25c)

DIAGNOSIS. Similar to other small species with roundish heads, parallel inner ventral margins of the compound eyes, and sparsely punctate pronotal upper corners; it can be recognized by the lack of rugae on the lateral area of the pronotum, yellow fore and middle coxae, fuscous first hind trochanter, elongate areola distant from the basal margin of the propodeum, generally weak propodeal carinae, fuscous metasoma except for the brownish red of the ventral 0.5 of T4-7, and enlarged ovipositor apex.

FEMALE: *Structure:* 1. Malar space about 0.3 as long as basal mandibular width. 2. Antenna with 34 flagellomeres. 3. Frontal and dorsal outlines of head as in fig. 21i-j; OOD about 1.0. 4. Genal width about 0.3. 5. Mesosomal profile as in fig. 25c; mesonotal profile strongly produced; subalar ridge weakly rugosopunctate. 6. Pronotum with epomia strong; lateral area with rugae weak or absent, on strongly granulate surface; upper corner with few scattered punctures on strongly granulate surface. 7. Mesopleurum with punctures in central region immediately below hypoepimeron about 0.1 OD, separated by about their diameter, on strongly granulate surface; scrobal groove with rugae extending from subalar ridge to 0.7 of distance to scrobe; hypoepimeron with punctures on dorsal and upper 0.5 of posterior margins. 8. Propodeum with areola elongate, juncture of areola-petiolar area moderately constricted, carinae generally weak and especially so in vicinity of juncture of areola-petiolar area (fig. 18m); areola strongly granulate, petiolar area with transverse rugae; first lateral area with scattered shallow punctures on granulate surface, second lateral area regularly granulosopunctate; propodeal neck about 0.8 as long as wide. 9. Hind femur about 5.2 as long as wide; hind basitarsus about 0.5 as long as hind tibial spur. 10. Areolet petiolate, stalk about 0.5 as long as cell. 11. FMS with petiole about 1.7 as long as postpetiole, post-petiole depressed (fig. 14u). S1 without grooves. 12. T2 about 2.4 as long as hind femur; metasoma moderately compressed. 13. Ovipositor about 2.8 as long as hind femur, moderately curved and with apex enlarged (fig. 4g). *Color:* Head and metasoma black, the following whitish yellow: mandible except for dark brown of base and apex, ventral surfaces of scape and pedicel, palpi, tegula, fore and middle coxae except for brown of extreme bases, extreme apex of hind coxa, and fore and middle trochanters. Remainder of fore and middle legs light brownish red. Hind leg with coxa and first trochanter fuscous; second trochanter whitish yellow; remainder of leg deep brownish red. Metasoma fuscous except for brownish red of lower lateral 0.5 of T4-7. *Length:* 5.7 mm; wing 3.7 mm; ovipositor 2.9 mm.

TYPE MATERIAL. Female holotype [CNCI], *MEXICO—Durango:* 3 mi. E. El Salto, 8500 ft., 4 July 1964, W.R.M. Mason.

ETYMOLOGY. The specific name is derived from the state in which the type locality is situated.

Venturia eremna, new species
(figs. 1a, 2b, 3g, 4e, 6, 13l, 15a, 19w-x, 22c, 29a-b)

DIAGNOSIS. This species can be distinguished from others with a completely fuscous-dark brown metasoma by the rather triangular outline of the head (fig. 19w), sparsely punctate pronotal upper corner, basally fuscous fore and middle coxae, somewhat elongate areola, two weak dorsolateral grooves of the petiole, and ovipositor with a weak dorsal nodus just before the apical notch.

FEMALE. *Structure:* 1. Malar space about 0.4 as long as basal mandibular width. 2. Antenna with 29-33 flagellomeres. 3. Frontal and dorsal outlines of head as in fig. 19w-x; OOD about 1.0. 4. Genal width about 0.4. 5. Mesosomal profile as in fig. 22c; mesonotal profile strongly produced; subalar ridge weakly rugosopunctate. 6. Pronotum with epomia strong; lateral area with low to moderate rugae, on weakly granulate surface; upper corner with shallow punctures ranging from widely scattered to separated by about 0.3 their diameter, on strongly granulate surface. 7. Mesopleurum with punctures in central region immediately below hypoepimeron about 0.1 OD, separated by 0.5-1.0 their diameter, on moderately granulate surface; scrobal groove with strong rugae

from subalar ridge to scrobe; hypoepimeron with fine punctures on dorsal and posterior margins. 8. Propodeum with areola somewhat elongate, juncture of areola-petiolar area moderately constricted (fig. 15a); areola with strongly granulate surface and occasionally with fine rugae, petiolar area with strong transverse rugae; first lateral area either with few shallow punctures or punctures absent, on granulate surface; second lateral area with regular shallow punctures on granulate surface; propodeal neck about 0.6 as wide as long. 9. Hind femur about 4.8 as long as wide; hind tibial spur about 0.5 as long as hind basitarsus. 10. Areolet petiolate, stalk about 0.4 as long as cell. 11. FMS with petiole about 1.6 as long as postpetiole and with two faint dorsolateral grooves, postpetiole high (fig. 13l). 12. T2 about 1.8 as long as apical width; metasoma moderately compressed. 13. Ovipositor 2.6-3.0 as long as hind femur, strongly curved; apex with weak nodus just before dorsal notch (fig. 4e). *Color:* Head and mesosoma black, the following whitish yellow: mandible except for brown of base and apex, palpi, scape and pedicel ventrally, tegula, apical 0.3 of fore and middle coxae, trochanters except for brown first hind trochanter, and dorsal basal spot of hind tibia. Remainder of fore and middle coxae varying from brownish yellow, to dark brown basally with rest brownish yellow. Fore and middle legs otherwise brownish red. Hind coxa fuscous. Hind femur and median 0.5 of tibia brownish red, basal and apical regions of tibia brown; hind tarsi brownish red. FMS black; remainder of metasoma dark brown-fuscous. *Length:* 4.8-7.8 mm (5.3 mm); wing 3.1-4.3 mm (3.4 mm); ovipositor 2.6-4.2 mm (3.1 mm).

MALE. *Structure:* Similar to female except antenna with 27-31 flagellomeres; genal width 0.5; mesopleurum often weakly granulate; scrobal groove with strong rugae from subalar ridge halfway to scrobe; propodeum with central area narrower and carinae higher and stronger; postpetiole depressed; right gonoforceps and S9 as in figs. 29a-b. *Color:* Similar to female except basal 0.5 of fore coxa, basal 0.7 of middle coxa, first hind trochanter, and hind femur and tibia, dark brown; second hind trochanter often yellowish brown; middle leg with apices of femur and tibia, occasionally brown. *Length:* 4.0-6.0 mm; wing 2.6-3.4 mm.

TYPE MATERIAL. Female holotype [HMTC], *UNITED STATES—North Carolina:* Macon Co., Highlands, 23 June 1977, H. & M. Townes. Paratypes, *CANADA—Ontario:* 1F [CNCI], St. Lawrence Isl. Nat. Park, "Grenadier I. Centre", 11 Aug. 1975, "code 2.225R", coll. by E. Sigler); *UNITED STATES—Arkansas:* 1F [HMTC], Crawford Co., Mountainsburg, 10-13 June 1971, P. Rush; *Delaware:* 1F [USNM], New Castle Co., Wilmington, 8 Aug. 1951, W.A. Connell; *Georgia:* 3MM [UGCA], 1M [DBWC], Clarke Co., Athens, 8-10 June 1969, 8-11 July 1969, 19-22 July 1969, 29-31 July 1969, "Malaise", R. & J. Matthews; *Iowa:* 1F [USNM], Woodbury Co., Sioux City, South Ravine, "swept mixt. veg.", C.N. Ainslie; *Kentucky:* 1F [MSUC], Floyd Co., Prestonburg, 20 June 1957, R.L. Fischer; 4FF [HMTC], 1F [DBWC], Trigg Co., Golden Pond, 26 May-10 June 1964 & 10 June-10 Aug. 1964, S.G. Breeland; 1F and 1M [HMTC], Trigg Co., Golden Pond, June 1965, "Malaise trap"; *Michigan:* 5FF and 2MM [MSUC], 2FF and 1M [DBWC], Kalamazoo Co., Gull Lake Biol. Station, 2 July 1963, 20 July 1964, 6 July 1965, 12 Jul 1965, 21 July 1965, 23 July 1965, 2 July 1967, 13 July 1969, 29 July 1969, R.L. Fischer; 1F [HMTC], Washtenaw Co., Ann Arbor, 14-16 July 1971, P. Rush; *New Jersey:* 1F [HMTC], Burlington Co., Moorestown, 2 Aug. 1939, H. & M. Townes; *North Carolina:* 8FF and 2MM [HMTC], 1F [DBWC], same data as holotype except collected 21 June 1977, 23 June 1977, 25 June 1977, and 26 June 1977; *Ohio:* 2FF and 6MM [CEDC], 2MM [DBWC], Muskingum Co., New Concord, 19 Aug. 1964, 22 Aug. 1964, 10 July 1966, 11 July 1966, 5-6 Aug. 1973, 4-9 Sept. 1973, "trap", C. Dasch; 1M [CEDC], Muskingum Co., Otsego, McAllister Biol. Station, 13-18 July 1976, C. Dasch; *Pennsylvania:* 1F [USNM], Monroe Co., Swiftwater, 2 July 1939, T.R. Gardner; *South Carolina:* 4FF [HMTC], 1F [DBWC], Greenville Co., Cleveland, 25 June 1961, 29 June 1961, 11 July 1961, 15 June 1976, G.F. Townes; *Virginia:* 1F [HMTC], Arlington Co., Arlington, 1 Aug. 1950, K.V. Krombein.

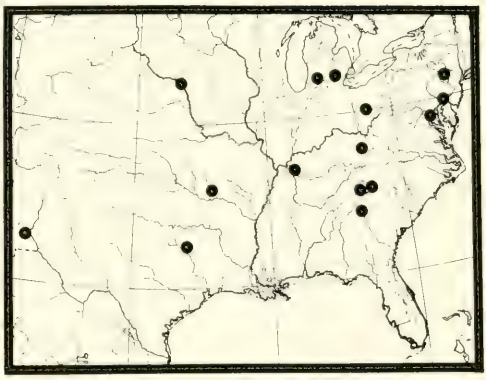

FIGURE 6. Localities for *Venturia eremna* Wahl.

OTHER SPECIMENS. *UNITED STATES—New Mexico:* 1F [MSUC], Grant Co., 14 mi. N. Silver City, 7 July 1961, G.C. Eickwort; *Texas:* 1F [USNM], Dallas Co., Dallas, 18 May 1907, F.C. Bishop.

COMMENT. Males are occasionally found with the apical 0.1 of T2 brownish red. Females sometimes have the brown of the hind tibia faint. Fig. 6 shows the distribution of this species.

ETYMOLOGY. From the Greek *eremnos,* black or swarthy, in reference to the general color of the insect.

Venturia erythrogaster, new species
(figs. 3i, 13r, 16c, 21v, 28a-b)

DIAGNOSIS. This species can be distinguished from others in the Hadra Group by the yellow first hind trochanter, somewhat elongate areola with the surface smooth and with weak transverse rugae, weakly granulate mesopleurum, brownish red metasoma with the fuscous markings confined to the petiole, and length (10.2-10.4 mm).

FEMALE. *Structure.* 1. Malar space about 0.3 as long as basal mandibular width. 2. Antenna with 44 flagellomeres. 3. Frontal outline of head similar to fig. 20o, dorsal outline as in fig. 21v; OOD about 0.5. 4. Genal width about 0.4. 5. Mesosomal profile similar to fig. 23g; mesonotal profile strongly produced; subalar ridge punctate. 6. Pronotum with strong epomia; lower part of collar distinctly punctate, not weakly rugosopunctate; lateral area with strong rugae except where obsolescent adjacent to front edge, on smooth surface; upper corner rugosopunctate, punctures separated by about 0.3 their diameter or occasionally subconfluent. 7. Mesopleurum with punctures in central region immediately below hypoepimeron about 0.1 OD, separated by 0.3-0.5 their diameter on smooth surface; scrobal groove with strong rugae from subalar ridge to scrobe, or with rugae occasionally obsolescent adjacent to scrobe; hypoepimeron with close punctures on dorsal and posterior margins. 8. Propodeum with areola somewhat elongate and narrowed basally, juncture of areola-petiolar area weakly constricted (fig. 16c); areola with transverse rugae on smooth surface, petiolar area reticulate; first lateral area with dense punctation on smooth surface, second lateral area rugosopunctate on smooth surface; propodeal neck about 0.4 as long as wide. 9. Hind femur about 5.3 as long as wide; hind tibial spur about 0.5 as long as hind basitarsus. 10. Areolet petiolate, stalk about 0.4 as long as cell. 11. FMS with petiole about 1.5 as long as postpetiole, postpetiole depressed (fig. 13r). 12. T2 about 1.4 as long as apical width; metasoma weakly compressed. 13. Ovipositor about 2.4 as long as hind femur, weakly curved; apex laterally flattened and minutely longitudinally aciculate. *Color:* Head and mesosoma black, the following whitish yellow: mandible except for brown of base and apex, palpi, ventral surfaces of scape and pedicel, tegula, apical 0.6 of fore coxa and apical 0.5 of middle coxa, fore and middle trochanters, and dorsal edge of fore tibia. Coxae fuscous except as noted otherwise. Remainder of fore and middle legs light brownish red. Remainder of hind leg brownish red. Basal 0.7 of petiole and ventral margin of postpetiole, extreme base of T2, fuscous; remainder of metasoma brownish red. *Length:* 11.4 mm (10.8 mm); wing 6.4 mm (6.4 mm); ovipositor 5.7 mm (5.7 mm).

MALE. *Structure:* Similar to female except genal width 0.5; antennae incomplete; propodeum with carinae stronger and higher; right gonoforceps and S9 as in figs. 28a-b. *Color:* Similar to female, except that first hind trochanter brown; basal 0.2 and apical 0.3 of T3, and basal median area of T4-7, fuscous; gonoforceps brown. *Length:* 10.2-10.4 mm; wing 6.0-6.4 mm.

TYPE MATERIAL. Female holotype [HMTC], *UNITED STATES—New York:* Suffolk Co., Babylon, 2 July 1937, F.S. Blanton. Paratypes, *UNITED STATES—Florida:* 1F [FSCA], Alachua Co., Gainesville, Pierce's Homestead, 21 May 1976, "Malaise trap," W.H. Pierce; *Michigan:* 1M [MSUC], Muskegon Co., 5 July 1958, R. & K. Dreisbach; 1M [MSUC], Oceana Co., 4 July 1940, R.R. Dreisbach; *Texas:* 1F [TAMU], Anderson Co., Salmon, 1-15 May 1974, H.R. Burke.

COMMENT: The FMS can have fuscous coloration extending to the basal 0.5 of the postpetiole.

ETYMOLOGY. From the Greek *erythros,* red, and *gaster,* belly, in reference to the almost completely brownish red metasoma. It is a noun in apposition.

Venturia erythropus (Ashmead)
(figs. 1b, 14n, 17f, 20i-j, 24g, 29e-f)

Limneria erythropus Ashmead, 1890 (1889). Proc. United States Nat. Mus. 12: 431. Male (USNM).

Limnerium erythropum Dalla Torre, 1901. Cat. Hymen., vol. 3, p. 95.

DIAGNOSIS. Distinguished from other species by the pronotal upper corner having shal-

low regular punctures on a strongly granulate surface, yellow fore and middle coxae, brown hind trochanters, light brownish red hind femur, elongate areola with a granulate surface, brownish red T4-7 except for the narrowly fuscous midlines, and long (2.7-3.1 as long as hind femur) ovipositor.

FEMALE. *Structure:* 1. Malar space about 0.4 as long as basal mandibular width. 2. Antenna with 35-40 flagellomeres. 3. Frontal outline of head as in fig. 20i-j; OOD about 0.5. 4. Genal width about 0.4. 5. Mesosomal profile as in fig. 24g; mesonotal profile strongly produced; subalar ridge weakly rugosopunctate. 6. Pronotum with weak epomia; lateral area weakly granulate with weak rugae; upper lateral corner with shallow regular punctures on strongly granulate surface, punctures separated by about 0.3 their diameter. 7. Mesopleurum with punctures in central region immediately below hypoepimeron about 0.1 OD, separated by 0.3-1.0 their diameter, on granulate surface; scrobal groove with strong rugae extending from subalar ridge to scrobe; hypoepimeron with few punctures on dorsal and posterior margins. 8. Propodeal area with areola elongate and basally rounded, weakly constricted at areola-petiolar juncture (fig. 17f); areola with weak transverse rugae on granulate surface, petiolar area striate-reticulate; first lateral area with shallow punctures on granulate surface, second lateral area weakly rugosopunctate on granulate surface; propodeal neck about 0.5 as long as wide. 9. Hind femur about 5.7 as long as wide; hind tibial spur about 0.5 as hind basitarsus. 10. Areolet petiolate, stalk 0.5 as long as cell. 11. FMS with petiole about 1.6 as long as postpetiole, postpetiole high (fig. 14n). 12. T2 about 2.0 as long as apical width; metasoma moderately compressed. 13. Ovipositor 2.7-3.2 as long as hind femur, moderately curved. *Color:* Head and mesosoma black, the following whitish yellow: mandible except for dark brown of base and apex, palpi, tegula, ventral surfaces of scape and pedicel, fore and middle coxae except for dark brown of extreme bases, and fore and middle trochanters. Hind coxa dark brown. Remainder of legs brownish-red, hind legs somewhat darker. Metasoma with FMS black; T2, T3 except for apicolateral corners, and midlines and upper portions of lateral areas of remaining terga, fuscous; remainder of metasoma brownish red. *Length:* 7.0-11.1 mm; wing 3.7-6.2 mm; ovipositor 3.6-6.2 mm.

MALE. *Structure:* Similar to female, except antenna with 38 flagellomeres (only one specimen with complete flagellum; genal width 0.5; propodeum with central area slightly narrower, carinae stronger and higher; right gonoforceps and S9 as in figs. 29e-f. *Color:* As in female, except brownish red of hind femur, tibia, and tarsi same as fore and middle legs; metasoma with T4-8 dark brown, except for brownish red of basilateral corners of T4, gonoforceps, and apices of T5-8. *Length:* of eleven males, only four had metasoma present, 6.1-8.8 mm (8.2 mm); wing 3.6-4.9 mm (4.7 mm).

SPECIMENS EXAMINED. Male holotype [USNM, type no. 2070], *UNITED STATES—Texas:* no other data, G.W. Belfrage, collector. Other specimens, *MEXICO—Hidalgo:* 1F [CNCI], Pachuca, 29 July 1954, 1700 ft., J.G. Chillcott; 1M [SEMC], 3 mi. W. Pachuca, 24 June 1954, "taken on pepper tree", University of Kansas Mexican Expedition; 1F [SEMC], 4 mi. E. Tulancingo, 24 Aug. 1962, 7100', E. Ordway and R. Roberts; *UNITED STATES—Florida:* 1F HMTC, Levy Co., Yankeetown, 12 Dec. 1949, H.K. Townes; 1F [MCZC], Putnam Co., Georgetown, April 1947, C.T. Brues; 1F [CNCI], Seminole Co, Longwood, 1-8 March 1975, W.R.M. Mason; *Missouri:* 4FF [CNCI], Wayne Co., Williamsville, May 1969 and 12-26 May 1969, "Malaise trap", J.T. Becker; *Texas:* 28FF and 10MM [USNM], same data as for holotype; 2FF [CNCI], Kerr Co., 30 March 1959, W.R.M. Mason.

COMMENT. The extent of the fuscous coloration on T4-8 is variable, rarely almost completely absent.

G.W. Belfrage who collected the holotype lived in Texas from 1867 to 1882.

Venturia finlaysonae, new species
(figs. 13s, 16a, 21z, 24j, 26a-b)

Venturia sp. B, Finlayson, 1975. Mem. Entomol. Soc. Canada 94: 23.

DIAGNOSIS. This species can be distinguished from others in the Hadra Group by the mesopleurum having the punctures separated by about their diameter, somewhat elongate areola with the surface granulate, dark brown hind leg, and fuscous metasoma.

FEMALE. *Structure:* 1. Malar space about 0.3 as long as basal mandibular width. 2. Antenna with 35-40 flagellomeres. 3. Frontal outline of head similar to fig. 20o, dorsal outline as in fig. 21z; OOD about 0.7. 4. Genal width about 0.4. 5. Mesosomal profile as in fig. 24j; mesonototal profile strongly produced; subalar ridge punctate to weakly rugosopunctate. 6. Pronotum with strong epomia; lateral area with moderate rugae, usually weak or absent centrally, on smooth surface; upper corner punctate, punc-

tures separated by about 0.3 their diameter, on smooth surface. 7. Mesopleurum with punctures in central region immediately below hypoepimeron about 0.1 OD, separated by about their diameter, on weakly granulate surface; scrobal groove with weak rugae extending from subalar ridge to scrobe; hypoepimeron with punctures on dorsal and upper 0.5 of posterior margins. 8. Propodeum with areola somewhat elongate, juncture of areola-petiolar area weakly to moderately constricted (fig. 16a); areola with some rugae on granulate surface, petiolar area with basal area reticulate, becoming apically transversely striate; first lateral area with scattered punctures on granulate surface, second lateral area regularly punctate on granulate surface; propodeal neck about 0.4 as long as wide. 9. Hind femur about 5.0 as long as wide; hind tibial spur about 0.5 as long as hind basitarsus. 10. Areolet petiolate, stalk about 0.3 as long as cell. 11. FMS with petiole about 1.7 as long as postpetiole, postpetiole depressed (fig. 13s). 12. T2 about 1.5 as long as apical width; metasoma weakly compressed. 13. Ovipositor 2.9-3.2 as long as hind femur, almost straight. *Color:* Head and mesosoma black, the following whitish yellow: mandible except for brown of base and apex, ventral surfaces of scape and pedicel, palpi, apical 0.4 of fore coxa, extreme apex of middle coxa, fore and middle trochanters, and dorsal surface of fore tibia. Remainder of fore and middle legs brownish red. Hind leg with coxa fuscous; remainder of leg, except for brownish yellow second hind trochanter and dorsal basal spot on tibia, dark brown. FMS black; remainder of metasoma dark brown-fuscous, except narrow brownish red bands along apices of T3-8. *Length:* 7.2-9.4 mm (9.1 mm); wing 4.8-6.0 mm (6.0 mm); ovipositor 4.1-6.0 mm (5.7 mm).

MALE. *Structure:* Similar to female, except antenna with 37-38 flagellomeres; pronotum with rugae of lateral area weak; scrobal groove extending halfway to scrobe; postpetiole often high; T2 about 2.5 as long as apical width; propodeal carinae higher and stronger; right gonoforceps and S9 as in figs. 26a-b. *Color:* Similar to female, except median 0.5 of hind femur brownish red; T2-8 dark brown-fuscous, the following areas brownish red: extreme apex of T2, T4 except for lateral apical spots, approximately median bands of T5-6, apices of T7-8, and gonoforceps. *Length:* 8.0-9.0 mm; wing 5.0-5.2 mm.

TYPE MATERIAL. Female holotype [CNCI], *CANADA—Ontario:* Cedar Lake Field Station, "1TA-54-1; F.I.S.; ex *Tetralopha asperatella*", emerged 5 July 1962. Paratypes, *CANADA—Manitoba:* 1M [CNCI], Whitemouth, "emer. 22 Sept. 1954; F.I.S.; W54-2724; ex *Tetralopha asperatella*"; *Ontario:* 1F [CNCI], Ardbeg, "no. 49-6723; 4 Oct. 1949; F.I.S.; lot 50-250"; 5FF and 3MM [CNCI], 1F and 3MM [DBWC], same data as holotype except emerged 1961—T-49-33, 1961—T-49-56, 1961—T-49-64, 1961—T-49-197, 2 July 1962—VTA-7-1, 5 July 1962—IITA-62-2, 6 July 1962—TT-1-1-1, 6 July 1962—VTA-65-3, 30 May 1963—1-TA-1-1, 30 May 1963—1-TA-30A-1, 30 May 1963—2-TA-13-2, 30 May 1963—TT-11-2; 1F [DBWC], Durham "emer. 9 March 1964; F.I.S.; A63-5701-01-5; ex *Tetralopha asperatella*"; 1F [CNCI], 1F [DBWC], St. Lawrence Isl. Nat. Park, "Grenadier I. Centre", 8 Aug. 1975 and 11 Aug. 1975, "Malaise trap; code 2-174R" and "code 2-225R", E. Sigler; 1M [CNCI], Vivian, "emer. 14 Sept. 1962; F.I.S.; S62-4515-01-01; ex *Tetralopha asperatella*"; 1F [CNCI], Wyevale, "no. 050-1471; 25 Feb. 1951; F.I.S.; ex *Tetralopha asperatella*"; *UNITED STATES—Massachusetts:* 1F [USNM], Essex Co., Wakefield, 25 Aug. 1982, "GipMothLab 12164T325; ex *Tetralopha asperatella*"; *New York:* 1F [HMTC], Dutchess Co., Poughkeepsie, 2 Aug. 1936, H.K. Townes.

COMMENT. One female (Ardbeg, Ontario) has the dark brown coloration of the metasoma much reduced, present only on the basal 0.5 of T2, and on irregular bands along the apices of T2-8. The remainder of T2-8 is brownish red. In addition, the hind femur is centrally deep brownish red.

ETYMOLOGY. This species is named after Thelma Finlayson, in recognition of her studies of larval ichneumonids, especially those of Porizontinae.

Venturia floridensis, new species

(figs. 14s, 18k, 21e-f, 25b, 28c-d)

DIAGNOSIS. This species may be distinguished by the predominately fuscous fore and middle coxae, elongate and narrow areola (fig. 18k), shape of the FMS, long T2, strongly compressed and predominately brownish red metasoma, and straight ovipositor that is about 2.5 as long as the hind femur.

FEMALE. *Structure:* 1. Malar space about 0.3 as long as basal mandibular width. 2. Antenna with 37-38 flagellomeres. 3. Frontal and dorsal outlines of head as in figs. 21e-f; OOD about 0.6. 4. Genal width about 0.3. 5. Mesosomal profile as in fig. 25b; mesonotal profile strongly produced; subalar ridge weakly rugosopunctate. 6. Pronotum with epomia strong; lateral

area with strong rugae on smooth surface; upper corner rugosopunctate, punctures separated by about 0.3 their diameter on smooth surface. 7. Mesopleurum with punctures in central region immediately below hypoepimeron about 0.1 OD, separated by 0.3-1.0 their diameter, on moderately granulate surface; scrobal groove with strong rugae extending from subalar ridge to scrobe, and covering considerable area of hypoepimeron; hypoepimeron with close punctures on dorsal and posterior margins. 8. Propodeum with areola elongate, juncture of areola-petiolar area weakly constricted (fig. 18k); areola with weak rugae on granulate surface, petiolar area basally reticulate becoming apically transversely striate; first lateral area with regular punctation on weakly granulate surface, second lateral area rugosopunctate on smooth surface; propodeal neck about 0.7 as long as wide. 9. Hind femur about 5.7 as long as wide; hind tibial spur about 0.5 as long as hind basitarsus. 10. Areolet petiolate, stalk about 0.3 as long as cell. 11. FMS with petiole about 1.5 as long as postpetiole, postpetiole depressed (fig. 14s). 12. T2 about 2.8 as long as apical width; metasoma strongly compressed. 13. Ovipositor about 2.4 as long as hind femur, straight. *Color:* Head and mesosoma black, the following whitish yellow: mandible except for dark brown of base and apex, ventral surfaces of scape and pedicel, palpi, tegula, apical 0.5 of fore coxae and apical 0.3 of middle coxa, trochanters, dorsal surface of fore tibia, and dorsal basal spot on hind tibia. Hind coxa and remainder of fore and middle coxa fuscous. Remainder of fore and middle legs light brownish red. Remainder of hind leg with femur brownish red, and tibia and tarsus brown. FMS fuscous except for brownish red of extreme apex of postpetiole. Basal 0.8 of T2 fuscous; remainder of metasoma brownish red. *Length:* 9.1-9.5 mm (9.1 mm); wing 4.9 mm (4.9 mm); ovipositor 4.4 mm (4.4 mm).

MALE. *Structure:* Similar to female except antenna with 37-38 flagellomeres; propodeum with central area narrower and carinae higher and stronger; right gonoforceps and S9 as in figs. 28c-d. *Color:* Similar to female except basal 0.9 of T2, T3, midlines of T4-5, and T6-7 except for narrow apical band, fuscous; remainder of metasoma brownish red. *Length:* 8.4-8.8 mm; wing 4.6-4.7 mm.

TYPE MATERIAL. Female holotype [FSCA], *UNITED STATES—Florida:* Putnam Co., 2 mi. NW Orange Spg., 13 Oct.-5 Nov. 1955, "Malaise trap", J. Wiley. Paratypes, *UNITED STATES—Florida:* 1F [DBWC], Highlands Co., Archbold Biol. Sta., 14 May 1978, "insect flight trap", L.L. Lampert, Jr. and H.V. Weems, Jr.; 1M [DBWC], same data as preceeding except collected 31 May 1978, H.V. Weems, Jr. and L.K. Klein; 1M [FSCA], Levy Co., Shell Mound, 3 July 1976, "netted", G.B. Fairchild; 1F [FSCA], Marion Co., 9 mi. SSW Ocala, 19 Sept.-8 Oct. 1975, "Malaise trap in turkey oak", J. Wiley.

ETYMOLOGY. The specific name derives from the state of Florida, where the species was collected.

Venturia fuscifemorata, new species
(figs. 13z, 17l, 20s-t, 24e, 25d-e)

DIAGNOSIS. Recognizable by the pronotal upper corner having a weakly granulate surface with the punctation concentrated along the margins, fuscous fore and middle coxae, dark brown first hind trochanter, dark brown middle and hind femora, elongate and narrow areola adjacent to the basal propodeal margin, granulate areolar surface with scattered punctures, high postpetiole, and brownish red T4-7 except for the narrow fuscous midlines.

FEMALE. *Structure:* 1. Malar space about 0.4 as long as basal mandibular width. 2. Antenna with 42-43 flagellomeres. 3. Frontal and dorsal outlines of head as in fig. 20s-t; OOD about 0.8. 4. Genal width about 0.4. 5. Mesosomal profile as in fig. 24e; mesonotal profile strongly produced; subalar ridge weakly rugosopunctate. 6. Pronotum with epomia strong; lateral area with strong rugae on smooth surface; upper corner with punctures concentrated along margins, punctures separated by about 0.3 their diameter, on weakly granulate surface. 7. Mesopleurum with punctures in central region immediately below hypoepimeron about 0.1 OD, separated by 0.5-1.0 (occas. 0.3) their diameter, on weakly-moderately granulate surface; scrobal groove with weak rugae extending from subalar ridge halfway to scrobe; hypoepimeron with punctures sparse or absent along dorsal and posterior margin. 8. Propodeum with areola elongate, juncture of areola-petiolar area weakly constricted (fig. 17l); areola with fine rugae and punctures on weakly granulate surface, petiolar area with strong transverse rugae; first lateral area with punctures mainly along lateral margins, on granulate surface; second lateral area with regular shallow punctation on granulate surface; propodeal neck about 0.6 as long as wide. 9. Hind femur about 5.4 as long as wide; hind tibial spur about 0.5 as long as hind basitarsus. 10. Areolet petiolate, stalk about 0.2 as long as cell. 11. FMS with petiole about 1.6 as long as postpetiole (fig. 13z); S1

with weak groove running down midline of central 0.5. 12. T2 about 2.6 as long as apical width; metasoma moderately compressed. 13. Ovipositor 3.0-3.2 as long as hind femur, almost straight. *Color:* Head and mesosoma black, the following whitish yellow: mandible except for brown of base and apex, palpi, ventral surface of scape, tegula, apical 0.2 of fore coxa, extreme apex of middle coxa, fore and middle trochanters, second hind trochanter, and apical 0.1 of middle femur. Fore and middle coxae otherwise dark brown. Basal 0.9 of middle femur, hind first trochanter, and remainder of hind leg, dark brown. FMS black except for brownish red apex of postpetiole. Basal 0.8 of T2, basal 0.3 of T3, and midline areas of T4-7, fuscous; remainder of metasoma brownish red. *Length:* 11.2 mm (11.1 mm); wing 5.9 mm (6.2 mm); ovipositor 5.7 mm (5.9 mm).

MALE. *Structure:* Similar to female except genal width 0.5; postpetiole depressed; propodeal carinae stronger and higher; right gonoforceps and S9 as in figs. 25d-e. *Color:* Similar to female except for fuscous coloration of T3, midlines of T4-6, and T7-8; one specimen with T3 having pair of lateral brownish red spots. *Length:* 9.8-9.9 mm; wing 5.3-5.5 mm.

TYPE MATERIAL. Female holotype [HMTC], *UNITED STATES—New York:* Tompkins Co., Ithaca, 6 Mile Creek, 26 July 1939, P. P. Babiy). Paratypes, *UNITED STATES—Connecticut-Rhode Island:* 1F [CUIC], Killingly Pond, South Shore, collected by Klots; *Massachusetts:* 1M [HMTC], Dukes Co., Martha's Vineyard, 14 Aug., F.M. Jones; *Pennsylvania:* 1M [USNM], Philadelphia, 28 June 1962.

ETYMOLOGY. From the Latin *fuscus,* dark or swarthy, and *femur,* in reference to the dark middle and hind femora.

Venturia gaesata, new species
(figs. 3h, 4d, 13c, 15c, 19k-l, 22h)

DIAGNOSIS. This species can be distinguished by the upper pronotal corner having dense punctures on a strongly granulate surface (appearing shagreened), predominately yellow fore and middle coxae, brownish red hind femur, fuscous first hind trochanter and metasoma, short areola, weakly compressed metasoma, and laterally compressed ovipositor.

FEMALE. *Structure:* 1. Malar space about 0.4 as long as basal mandibular width. 2. Antenna with 30-33 flagellomeres. 3. Frontal and dorsal outlines of head as in fig. 19k-l; OOD about 0.8. 4. Genal width about 0.3. 5. Mesosomal profile as in fig. 22h; mesonotal profile strongly produced; subalar ridge weakly rugosopunctate. 6. Pronotum with epomia strong; lateral area with weak rugae on weakly granulate surface; upper corner with indistinct punctures separated by 0.3-0.5 their diameter, on strongly granulate surface. 7. Mesopleurum with punctures in central region immediately below hypoepimeron about 0.1 OD, separated by 0.5-1.0 their diameter, on strongly granulate surface; scrobal groove with strong rugae extending from subalar ridge halfway to scrobe; hypoepimeron with punctures on dorsal and posterior margins absent. 8. Propodeum with areola as long as wide, juncture of areola-petiolar area moderately constricted (fig. 15c); areola strongly granulate, petiolar area with fine transverse rugae; first lateral area with indistinct punctures on granulate surface, second lateral area rugosopunctate on weakly granulate surface; propodeal neck about 0.4 as long as wide. 9. Hind femur about 4.2 as long as wide; hind tibial spur about 0.5 as long as hind basitarsus. 10. Areolet petiolate, stalk about 0.6 as long as cell. 11. FMS with petiole about 1.7 as long as postpetiole, postpetiole high (fig. 13c). 12. T2 about 1.5 as long as apical width; metasoma weakly compressed. 13. Ovipositor 2.6-2.9 as long as hind femur, strongly curved and laterally flattened; apex elongate (fig. 4d). *Color:* Head and mesosoma black, the following whitish yellow: mandible except for brown of base and apex, palpi, scape and pedicel ventrally, tegula, fore coxa except for extreme base and basal 0.3 of middle coxa, extreme apex of hind coxa, and fore and middle trochanters. Fore and middle coxae otherwise dark brown. Fore and middle legs otherwise light brownish red. Hind leg with coxa and first trochanter, fuscous; second trochanter, femur except for basal and apical 0.2, median 0.5 of tibia, brownish red; ventral surfaces of tarsomeres brownish yellow; leg otherwise dark brown. FMS black; remainder of metasoma, except for brownish red of extreme apices and ventral 0.2 of lateral areas of T4-7, fuscous. *Length:* 5.5-6.8 mm (6.8 mm); wing 3.5-4.0 mm (4.0 mm); ovipositor 3.2-4.0 mm (4.0 mm).

TYPE MATERIAL. Female holotype [HMTC], *UNITED STATES—Oregon:* Benton Co., Corvallis, 27 July 1978, H. & M. Townes. Paratypes, *UNITED STATES—Arkansas:* 1M [HMTC], Crawford Co., Mountainsburg, 10-13 June 1971, P. Rush; *Florida:* 1F [HMTC], Alachua Co., Gainesville, 14 July 1981, H. & M. Townes; *Georgia:* 1F [CNCI], Forsyth Co., Forsyth, Aug. 1970, "Malaise trap", F.T. Naumann; *Louisiana:* 1F [HMTC], Rapides Parish, 8-11 May 1973, P. Rush; *Mis-*

souri: 1F [CNCI], Wayne Co., Williamsville, Oct.-Nov. 1968, "Malaise trap", J.T. Becker; *New Jersey:* 1F [DBWC], Burlington Co., Moorestown, 27 June 1939, H. & M. Townes; *North Carolina:* 1F [HMTC], Wake Co., 1 July 1951, H. & M. Townes; *Oregon:* 1F [HMTC], 2FF [DBWC], same data as for holotype except collected 29 July 1978 and 31 July 1978; *South Carolina:* 1F [HMTC], Greenville Co., Cleveland, 2 July 1961, G.F. Townes.

COMMENT. The dark brown coloration of the hind femur is sometimes absent with the entire femur deep brownish red. The second hind trochanter can be brownish yellow, and the brownish red areas of the metasoma can be absent.

ETYMOLOGY. From the Latin *gaesum,* a long and heavy javelin of the Gauls, in reference to the long and laterally compressed ovipositor.

Venturia gelechiae (Ashmead)

(figs. 14q, 15e, 19aa-bb, 22m)

Limneria gelechiae Ashmead, 1890 (1889). Proc. United States Nat. Mus. 12: 432. Female (USNM).

DIAGNOSIS. This species can be distinguished from others in the Gelechiae Group by the predominately dark brown fore and middle coxae, light brownish red hind leg, areola about as long as wide, presence of an areolet, and fuscous metasoma.

FEMALE. *Structure:* 1. Malar space about 0.3 as long as basal mandibular width. 2. Antenna with 31-33 flagellomeres. 3. Frontal and dorsal outlines of head as in fig. 19aa-bb; eyes ventrally convergent; OOD about 0.9. 4. Genal width about 0.4. 5. Mesosomal profile as in fig. 22m; mesonotal profile strongly produced; subalar ridge weakly rugosopunctate. 6. Pronotum with epomia strong; lateral area with strong rugae on weakly granulate surface; upper corner with scattered punctures on strongly granulate surface. 7. Mesopleurum with punctures in central region immediately below hypoepimeron about 0.1 OD, separated by 0.5-1.0 their diameter, on moderately-weakly granulate surface; scrobal groove with strong rugae from subalar ridge halfway to scrobe; hypoepimeron with sparse punctures on dorsal and posterior margins. 8. Propodeum with areola about as long as wide, juncture of areola-petiolar region weakly constricted (fig. 15e); areola with few weak rugae on strongly granulate surface, petiolar area with fine transverse rugae; first lateral area with regular punctation on granulate surface, second lateral area rugosopunctate on granulate surface; propodeal neck about 0.5 as long as wide. 9. Hind femur about 4.9 as long as wide; hind tibial spur about 0.5 as long as hind basitarsus. 10. Areolet petiolate, stalk about 0.5 as long as cell. 11. FMS with petiole about 1.6 as long as postpetiole, postpetiole high (fig. 14q). 12. T2 about 2.0 as long as apical width; metasoma moderately compressed. 13. Ovipositor 2.8-3.1 as long as hind femur, weakly curved. *Color:* Head and mesosoma black, the following whitish yellow: mandible except for brown of base and apex, palpi, tegula, apical 0.5 of fore coxa and apical 0.3 of middle coxa, extreme apex of hind coxa, trochanters except for brown first hind trochanter, dorsal surface of fore tibia, and dorsal basal spot of hind tibia. Fore and middle coxae otherwise dark brown-fuscous. Remainder of fore and middle legs light brownish red. Hind femur except for brown of apical 0.2, and median 0.5 of hind tibia, brownish red; hind tarsi and remainder of hind tibia brown. Metasoma dark brown-fuscous except for brownish red of apical 0.2 of T2. *Length:* 5.4-7.1 mm (7.1 mm); wing 3.4-4.1 mm (4.1 mm); ovipositor 3.2-4.1 mm (4.1 mm).

MALE. *Structure:* Similar to female except antenna with 30-34 flagellomeres; eyes not ventrally convergent; genal width 0.5; propodeum with central area narrower and carinae stronger and higher; postpetiole depressed. *Color:* Similar to female except hind femur, tibia, and tarsi uniformly light to dark brown, except for yellowish white dorsal basal spot of hind tibia; gonoforceps dark brown-fuscous. *Length:* 6.8 mm (5.3 mm); wing 3.9 mm (3.2 mm).

SPECIMENS EXAMINED. Female holotype [USNM], type no. 2074, *UNITED STATES—Missouri:* St. Louis Co., Kirkwood, 15 May 1885, M. Murtfeldt, "par. on *Gelechia celtisella* 8/19/84". Allotype [USNM], type no. 2074, same data as for holotype. Other specimens, *UNITED STATES—Kansas:* 1F [DBWC], Douglas Co., Breidenthal Reserve, 2 mi. N. Baldwin, 11-16 Sept. 1982, D.B. Wahl; 2FF [DBWC], Douglas Co., Lawrence, 11-19 June 1982 and 19-30 June 1982, "Malaise trap", D.B. Wahl; 3FF [USNM], Riley Co., Manhattan, 1935 and 25 July 1937, 1935 specimens from *Gelechia cercerisella* Chamb., R.L. Parker; *Louisiana:* 1F [CNCI], Evangeline Parish, Bayou Chicot, 15 May-11 June 1971, D. Shanek; *Maryland:* 1F [USNM], Montgomery Co., Glen Echo, 21 Aug. 1923, J.R. Malloch; 1F [USNM], Montgomery Co., Plummers Island, 8 Sept. 1963, K.V. Krombein; *Missouri:* 2FF CNCI, Wiley Co., Williamsville, 16-26

June 1969, "Malaise trap", J.T. Becker; 1F [USNM], Boone Co., Columbia, 20 June 1967, "Malaise trap; 7am-4pm", F.D. Parker; *North Carolina:* 1F [CEDC], Yancey Co., Mt. Mitchell, 17 Aug. 1970, 5500', "trap", C. Dasch; *Virginia:* 1F [MCZC], Fairfax Co., Great Falls, A.L. Melander; 1F [USNM], Fairfax Co., Great Falls, "reared 13 June '04; C. Heinrich; *Gelechia cercerisella* on *Cerceris;* 11187b Hopk.U.S."

COMMENT. Females occasionally have brownish red highlights on the lateral areas and apices of T3-7. The usual basal dark brown of the fore and middle coxae is sometimes lighter, merging gradually into the yellow apical areas.

Venturia hadra, new species
(figs. 13o, 16b, 21x, 23d, 26c-d)

DIAGNOSIS. This species can be distinguished from others in the Hadra Group by the weakly to moderately granulate mesopleurum, elongate areola with the surface granulate, and by the brownish red metasoma with fuscous markings on T2 and the basal 0.3 of T3.

FEMALE. *Structure:* 1. Malar space about 0.4 as long as basal mandibular width. 2. Antenna with 38-41 flagellomeres. 3. Frontal outline of head similar to fig. 20o, dorsal outline as in fig. 21x; OOD about 0.8. 4. Genal width about 0.4. 5. Mesosomal profile as in fig. 23d; mesonotal profile strongly produced; subalar ridge weakly rugosopunctate. 6. Pronotum with strong epomia; lateral area with strong rugae on weakly granulate surface; upper corner rugosopunctate, punctures separated by about 0.3 their diameter. 7. Mesopleurum with punctures in central region immediately below hypoepimeron about 0.1 OD, separated by about their diameter, on weakly-moderately granulate surface; scrobal groove with strong rugae extending from subalar ridge halfway to scrobe; hypoepimeron with punctures on dorsal and upper 0.5 of posterior margins. 8. Propodeum with areola elongate, juncture of areola-petiolar area moderately constricted (fig. 16b); areola granulate with scattered punctures, petiolar area with strong transverse rugae; first lateral area with scattered punctures on granulate surface, second lateral area with close punctures on granulate surface; propodeal neck about 0.4 as long as wide. 9. Hind femur about 5.0 as long as wide; hind tibial spur about 0.5 as long as hind basitarsus. 10. Areolet petiolate, stalk about 0.5 as long as cell. 11. FMS with petiole about 1.5 as long as postpetiole, postpetiole depressed (fig. 13o). 12. T2 about 1.4 as long as apical width; metasoma weakly compressed. 13. Ovipositor 2.7-3.0 as long as hind femur, almost straight. *Color:* Head and mesosoma black, the following whitish yellow: mandible except for brown of base and apex, palpi, ventral surfaces of scape and pedicel, tegula, apical 0.4 of fore coxa and apical 0.2 of middle coxa, trochanters except for dark brown first hind trochanter, dorsal edge of fore tibia, and dorsal basal spot on hind tibia. Coxae, except where noted otherwise, fuscous; remainder of fore and middle legs light brownish red. Remainder of hind leg dark brown except for median brownish red of femur. FMS fuscous (except, occasionally, extreme apex); basal 0.8 of T2, basal 0.3 of T3, and basal median areas of T5-8, fuscous-dark brown; remainder of metasoma brownish red. *Length:* 7.8-9.7 mm (9.5 mm); wing 5.1-6.3 mm (6.3 mm); ovipositor 4.6-5.7 mm (5.7 mm).

MALE. *Structure:* Similar to female, except antenna with 38-40 flagellomeres; genal width 0.5; propodeum with carinae stronger and higher; T2 about 2.3 as long as apical width; right gonoforceps and S9 as in figs. 26c-d. *Color:* Similar to female, except that metasoma fuscous except for brownish red of apical 0.1 of T2, lateral ovoid area of T3, T4, and either T5-7 except for basal median area, or only T5 and apical margins of T6-7; gonoforceps brownish red. *Length:* 8.2-8.5 mm; wing 5.5-6.0 mm.

TYPE MATERIAL. Female holotype [HMTC], *UNITED STATES—Michigan:* Livingston Co., E.S. George Reserve, 27 July 1961, D.F. Owen. Paratypes, *UNITED STATES—Alabama:* 2FF [USNM], 1F [DBWC], Randolph Co., Wadley, H.H. Smith; *Georgia:* 2FF [CNCI], Forsyth Co., Forsyth, 24 June 1971, F.T. Naumann; *Massachusetts:* 1F [MCZC], Dukes Co., Martha's Vineyard, 23 Aug. 1931, C.W. Johnson; *New Jersey:* 1M [DBWC], Burlington Co., Moorestown, 22 July 1939, H. & M. Townes; *North Carolina:* 1M [HMTC], Hertford Co., Murfreesboro, 15 Sept. 1938, G.E. Burdick; *Pennsylvania:* 2MM [HMTC], Lackawanna Co., Spring Brook, 13 Aug. 1944, H.K. Townes; *Wisconsin:* 1F [USNM], LaFayette Co., Shullsburg, 24 Aug. 1949, R.E. Ryckman.

COMMENT. Females occasionally have dark markings on T5-8.

ETYMOLOGY. From the Greek *hadros,* stout or strong, in reference to the overall bulky appearance.

Venturia hibiscellae, new species
(figs. 14h, 17b, 21r, 24a)

DIAGNOSIS. Recognizable by the rugosopunctate pronotal upper corner, yellow fore and

middle coxae, yellow hind trochanter, light brownish red hind femur, deep mesopleural punctures on a strongly granulate surface, somewhat elongate areola distant from the basal propodeal margin, and dark brown metasoma except for brownish red of the lower lateral 0.5 of T4-7 (completely dark brown in two specimens).

FEMALE. *Structure:* 1. Malar space about 0.4 as long as basal mandibular width. 2. Antenna with 31-32 flagellomeres. 3. Frontal outline of the head similar to fig. 20o, dorsal outline as in fig. 21r; OOD about 0.9. 4. Genal width about 0.4. 5. Mesosomal profile as in fig. 24a; mesonotal profile strongly produced; subalar ridge weakly rugosopunctate. 6. Pronotum with epomia strong; lateral area with strong rugae, surface weakly granulate in parts; upper corner rugosopunctate, punctures separated by about 0.3 their diameter. 7. Mesopleurum with punctures in central region immediately below hypoepimeron about 0.2 OD, separated by about 0.3 their diameter or contiguous, on strongly granulate surface; scrobal groove with strong rugae from subalar ridge halfway to scrobe; hypoepimeron with punctures on dorsal and upper 0.5 of posterior margin. 8. Propodeum with areola somewhat elongate, juncture of areola-petiolar area moderately constricted (fig. 17b); areola with few rugae on granulate surface, petiolar area with strong transverse rugae; first lateral area with shallow regular punctation on granulate surface, second lateral area rugosopunctate on granulate surface; propodeal neck about 0.6 as long as wide. 9. Hind femur about 5.1 as long as wide; hind tibial spur about 0.5 as long as hind basitarsus. 10. Areolet petiolate, stalk about 0.4 as long as cell. 11. FMS with petiole about 1.5 as long as postpetiole (fig. 14h). 12. T2 about 2.0 as long as apical width; metasoma moderately compressed. 13. Ovipositor 2.9-3.2 as long as hind femur, moderately curved. *Color:* Head and mesosoma black, the following whitish yellow: mandible except for brown of base and apex, palpi, scape and pedicel ventrally, tegula, fore and middle coxae except for extreme bases, trochanters, dorsal surface of fore tibia, and dorsal basal spot of hind tibia. Remainder of fore and middle legs brown. Hind coxa fuscous. Remainder of hind leg light brownish red, except for dark brown of subbasal and apical bands of hind tibia. Apical 0.2 of T2, and lower lateral areas of T4-7, brownish red; remainder of metasoma dark brown-fuscous. *Length:* 5.7-6.4 mm (7.4 mm); wing 3.6-4.1 mm (4.4 mm); 3.5-3.9 mm (4.3 mm).

TYPE MATERIAL. Female holotype [HMTC], *UNITED STATES—Maryland:* Calvert Co., North Beach, July, M. Vogel. Paratypes, *UNITED STATES—New Jersey:* 2FF [USNM], Bergen Co., Rutherford, one specimen with label data: "bred from *Gelechia hibiscella;* rec'd from E.L. Dickerson", other specimen with: "H.B. Weiss, coll.; parasitic on larva of hibiscus leaf roller, July 1924, *Gelechia hibiscella* Busck, det. C.H."

OTHER SPECIMENS. *UNITED STATES—Maryland:* 2FF [USNM], Calvert Co., Chesapeake Beach, emerged 24 Aug. 1915, "Host: *Gelechia hibiscella;* H. and DeG. colrs.".

COMMENT. One of the specimens from Rutherford, NJ, has an almost completely brown middle coxa and lacks distinct brownish red markings on the lower lateral areas of the metasoma. The specimens from Chesapeake Bay, Maryland, have the postpetiole and T2-7 deep reddish brown, with only the apical 0.2 of T2 somewhat lighter. One of them varies in that the upper corner of the lateral area of the propodeum is not rugosopunctate, but rather has close punctures on a weakly granulate surface that has a few weak rugae. It is like the other specimens of the species in all other characters.

ETYMOLOGY. The specific name derives from the name of the host, *Chionodes hibiscella* (Busk).

Venturia latrunculus, new species
(figs. 13m, 16k, 20c-d, 23f)

DIAGNOSIS. This species can be distinguished from others with a completely dark brown metasoma by the rather triangular frontal outline of the head (fig. 9m), sparsely punctate upper pronotal margin, brownish fore and middle coxae except for the yellowish apices, light brown hind femur, and somewhat elongate areola with a granulate surface.

FEMALE. *Structure:* 1. Malar space about 0.3 as long as basal mandibular width. 2. Antenna with 32 flagellomeres. 3. Frontal and dorsal outlines of head as in fig. 20c-d; OOD about 0.9. 5. Genal width about 0.5. 5. Mesosomal profile as in fig. 23f; mesonotal profile strongly produced; subalar ridge punctate. 6. Pronotum with strong epomia; lateral area with weak rugae on weakly granulate surface; upper corner with scattered punctures on granulate surface, punctures separated by 0.5-1.0 their diameter. 7. Mesopleurum with punctures in central region immediately below hypoepimeron about 0.1 OD, separated by 0.3-0.5 their diameter (occas. 1.0), on strongly granulate surface; scrobal groove with weak rugae extend-

ing from subalar ridge to scrobe; hypoepimeron with sparse punctures on dorsal and posterior surfaces. 8. Propodeum with areola somewhat elongate, juncture of areola-petiolar area weakly constricted (fig. 16k); areola strongly granulate, petiolar area with fine transverse rugae; first and second lateral areas with regular punctation on granulate surface; propodeal neck about 0.5 as long as wide. 9. Hind femur about 5.3 as long as wide; hind tibial spur about 0.5 as long as hind basitarsus. 10. Areolet petiolate, stalk about 0.4 as long as cell. 11. FMS with petiole about 1.6 as long as postpetiole (fig. 13m). 12. T2 about 1.8 as long as apical width; metasoma moderately compressed. 13. Ovipositor about 2.5 as long as hind femur, weakly curved. *Color:* Head and mesosoma black, the following whitish yellow: mandible except for brown of base and apex, palpi, scape and pedicel ventrally, tegula, apical 0.3 of fore coxa and extreme apex of middle coxa, and dorsal basal spot of hind tibia. Coxae otherwise dark brown. Remainder of legs brownish red, except hind tibia with brownish sub-basal and apical bands. FMS with petiole black, postpetiole deep brown with apical 0.3 brownish red. brownish red; remainder of metasoma dark brown-fuscous. *Length:* 7.4 mm; wing 4.2 mm; ovipositor 4.1 mm.

TYPE MATERIAL. Female holotype [MCZC], *UNITED STATES—Nebraska:* Red Willow Co., Indianola, 5 June, A.P. Morse.

ETYMOLOGY. From the Latin *latrunculus*, little brigand, in reference to the vicious nature of the female wasp. It is a noun in apposition.

Venturia leptogaster (Cameron)

(figs. 13a, 15i, 19o-p, 22n, 25j-k)

Limnerium leptogaster Cameron, 1904. Trans. American Entomol. Soc. 30: 256. Male (BMNH).

Limnerium centrale Cameron, 1904. Trans. American Entomol. Soc. 30: 257. Male (BMNH).

DIAGNOSIS. Although known only from male specimens, the narrow and elongate areola, long propodeal neck (0.7 as long as wide), and elongate FMS will distinguish this species.

MALE. *Structure:* 1. Malar space about 0.5 as long as basal mandibular width. 2. Antenna with 35 flagellomeres (type with antennae incomplete). 3. Frontal and dorsal outlines of head as in fig. 19o-p; OOD about 1.0. 4. Genal width about 0.5. 5. Mesosomal profile as in fig. 22n; mesonotal profile strongly produced; subalar ridge weakly rugosopunctate. 6. Pronotum with epomia strong; lateral area with strong rugae except where absent adjacent to front margin, on smooth surface; upper corner with punctures separated by 0.5-1.0 their diameter, on granulate surface. 7. Mesopleurum with punctures in central region immediately below hypoepimeron about 0.1 OD, separated by 0.3-0.5 their diameter, on weakly-moderately granulate surface; scrobal groove with strong rugae extending from subalar ridge to scrobe; hypoepimeron without punctures on dorsal margin, few punctures on posterior margin. 8. Propodeum with areola elongate, juncture of areola-petiolar area weakly constricted (fig. 15i); carinae not high and strong as is usual for males; areola with weak rugae on smooth surface, petiolar area with strong transverse rugae; first lateral area with shallow regular punctation on granulate surface, second lateral area weakly rugosopunctate on smooth surface; propodeal neck about 0.7 as long as wide. 9. Hind femur about 5.4 as long as wide; hind tibial spur about 0.5 as long as hind basitarsus. 10. Areolet petiolate, stalk about 0.4 as long as cell. 11. FMS with petiole about 2.0 as long as postpetiole, postpetiole depressed (fig. 13a). 12. T2 about 2.7 as long as apical width. 13. Right gonoforceps and S9 as in figs. 25j-k. *Color:* Head and mesosoma black, the following whitish yellow: mandible except for brown of base and apex, palpi, scape and pedicel ventrally, fore and middle coxae except for brownish tinge of basal 0.5, and trochanters. Remainder of fore and middle legs brownish red except for brown of apical fore tarsomeres and middle tarsi. Remainder of hind leg with femur brownish red except for dark brown of basal and apical 0.2; tibia and tarsi dark brown. FMS black. Apical 0.2 of T2, apicolateral corners of T3, lateral area of T4, and triangular regions on lateral areas of T5-6, brownish red; remainder of metasoma fuscous. *Length:* 5.8-6.5 mm (6.2 mm); wing 3.7-3.9 mm (3.8 mm).

SPECIMENS EXAMINED. Male holotype of *V. leptogaster* [BMNH], type no. 3.b.1404, *MEXICO* (no other data). Male holotype of *Limneria centrale* [BMNH], type no. 3.b.1405, *MEXICO* (no other data). Other specimens, *MEXICO—Veracruz:* 1M [UCDC], Cordoba, 18 July 1966, J.S. Bucket, M. & R. Gardner; *UNITED STATES—Texas:* 1M [HMTC], Cameron Co., Brownsville, 30 Dec. 1980, H. & M. Townes.

COMMENT. The holotype of *leptogaster* and the specimen from Brownesville, Texas, have the coloration as in the above description. The type of *centrale* and the specimen from Cordoba,

Mexico, have the metasomal coloring with the brownish red areas reduced, with only hints of brownish red on the lower lateral areas of T4-6. In addition, the Cordoba specimen has the hind femur entirely dark brown.

The female of *leptogaster* is probably similar to that of *mayi*. The two species differ in the following (taking into account that different sexes are being compared): 1) the upper corner of the pronotum is more punctate in *mayi;* 2) the section of the median longitudinal carina basal to the areola is much longer in *mayi;* 3) the propodeal carinae of *leptogaster* are not high and strong, as is usual for males, so that the differences in the pattern of the central area is not due to sexual dimorphism; and 4) the second lateral area in *leptogaster* is weakly rugosopunctate, while that of *mayi* is granulate. I believe these differences are due to specific divergence rather than sexual dimorphism.

Venturia licina, new species
(figs. 4f, 14r, 18j, 21c-d, 25a, 25f-g)

DIAGNOSIS. This species can be distinguished by the deep brownish red fore and middle coxae, weakly granulate mesopleurum with punctures separated by 0.5-1.0 their diameter, somewhat elongate areola, predominately brownish red metasoma, and cylindrical ovipositor that is almost straight except for the sharply curved apex.

FEMALE. *Structure:* 1. Malar space about 0.3 as long as basal mandibular width. 2. Antenna with 32 flagellomeres. 3. Frontal and dorsal outlines of head as in fig. 21c-d; OOD about 0.6. 4. Genal width about 0.3 5. Mesosomal profile as in fig. 25a; mesonotal profile strongly produced; subalar ridge weakly rugosopunctate. 6. Pronotum with epomia strong; lateral area with strong rugae on smooth surface; upper corner rugosopunctate, punctures separated by about 0.3 their diameter. 7. Mesopleurum with punctures in central region immediately below hypoepimeron about 0.1 OD, separated by 0.5-1.0 their diameter, on weakly granulate surface; scrobal groove with strong rugae from subalar ridge halfway to scrobe; hypoepimeron with close punctures on dorsal and posterior margins. 8. Propodeum with areola somewhat elongate, juncture of areola-petiolar area moderately constricted (fig. 18j); areola with weak transverse rugae on smooth surface, petiolar area with strong rugae, basally reticulate becoming apically transverse; first lateral area with scattered punctures on granulate surface, second lateral area rugosopunctate on granulate surface; propodeal neck about 0.7 as long as wide. 9. Hind femur about 5.0 as long as wide; hind tibial spur about 0.5 as long as hind basitarsus. 10. Areolet petiolate, stalk about 0.5 as long as cell. 11. FMS with petiole about 1.6 as long as postpetiole, postpetiole high (fig. 14r). 12. T2 about 1.8 as long as wide; metasoma moderately compressed. 13. Ovipositor about 2.6 as long as hind femur, cylindrical and almost straight except for sharply upcurved apex (fig. 4f). *Color:* Head and mesosoma black, the following whitish yellow: mandible except for dark brown of base and apex, ventral surfaces of scape and pedicel, palpi, tegula, and fore and middle trochanters. Fore and middle coxae deep brownish red. Remainder of fore and middle legs light brownish red. Hind coxa fuscous. Remainder of hind leg light brownish red except for whitish yellow of first trochanter, and brown of tarsus and sub-basal and apical areas of tibia. FMS with petiole fuscous and postpetiole deep brownish red. Basal 0.4 of T2, and basal 0.3 and midline of T3, dark brown-fuscous; remainder of metasoma brownish red. *Length:* 6.2 mm; wing 3.8 mm; ovipositor 3.5 mm.

MALE. *Structure:* Similar to female except genal width 0.5; propodeum with central area narrower and carinae higher and stronger; T2 about 2.1 as long as wide; right gonoforceps and S9 as in figs. 25f-g. *Color:* Similar to female except basal 0.3-0.5 of fore and middle coxae brown; basal 0.3 of T2, T3, and median basal 0.3-0.5 of T5-7, dark brown-fuscous; remainder of metasoma brownish red. *Length:* 6.9 mm; wing 3.9 mm.

TYPE MATERIAL. Female holotype [FSCA], *UNITED STATES—Florida:* Gainesville, 18 July 1958, "at window 5th floor", H.V. Weems, Jr.. Male paratype [FSCA], *UNITED STATES—Florida:* Gainesville, Doyle Connor Bldg., 19 Sept. 1972, "blacklight trap", F.W. Mead.

ETYMOLOGY. From the Latin *licinus,* bent or turned upward, in reference to the upturned ovipositor apex.

Venturia longicuspis, new species
(figs. 4b, 14b, 17i, 21p, 23i)

DIAGNOSIS. Recognizable by the rugosopunctate pronotal upper corner, apically yellow fore and middle coxae, yellow hind trochanters, light brownish red hind femur, somewhat elongate areola adjacent to the basal propodeal margin, short (0.4 as long as wide) propodeal neck, elongate FMS with high postpetiole, short

(1.5 as long as apical width) T2, weakly compressed metasoma, brownish red T4-7 except for a few fuscous spots on the midlines, and short (2.1-2.2 as long as hind femur) ovipositor.

FEMALE. *Structure:* 1. Malar space about 0.4 as long as basal mandibular width. 2. (Antennae incomplete). 3. Frontal outline of head similar to fig. 20c, dorsal outline as in fig. 21p; OOD about 1.0. 4. Genal width about 0.3. 5. Mesosomal profile as in fig. 23i; mesonotal profile strongly produced; subalar ridge weakly rugosopunctate. 6. Pronotum with strong epomia; lateral area with rugae strong except where obsolescent adjacent to front margin, on smooth surface; upper corner rugosopunctate, punctures separated by about 0.3 their diameter, on smooth surface. 7. Mesopleurum with punctures in central region immediately below hypoepimeron about 0.1 OD, separated by 0.3-0.5 their diameter, on weakly granulate surface; scrobal groove with weak rugae from subalar ridge halfway to scrobe; hypoepimeron with close punctures on dorsal and posterior margins. 8. Propodeum with somewhat elongate areola, juncture of areola-petiolar area moderately constricted (fig. 17i); areola with weak rugae on weakly granulate surface, petiolar area with strong transverse rugae; first lateral area with regular punctation on weakly granulate surface, second lateral area rugosopunctate on smooth surface; propodeal neck about 0.4 as long as wide. 9. Hind femur about 4.7 as long as wide; hind tibial spur about 0.5 as long as hind basitarsus. 10. Areolet petiolate, stalk about 0.3 as long as cell. 11. FMS with petiole about 1.8 as long as postpetiole, postpetiole high (fig. 14b). 12. T2 about 1.5 as long as apical width; metasoma weakly compressed. 13. Ovipositor 2.1-2.2 as long as hind femur, straight except for apical curvature; apex elongate (fig. 4b). *Color:* Head and mesosoma black, the following whitish yellow: mandible except for brown of base and apex, palpi, scape and pedicel, tegula, apical 0.5 of fore coxa, apical 0.3 of middle coxa, extreme apex of hind coxa, trochanters, dorsal surface of fore tibia, and dorsal basal spot of hind tibia. Remainder of fore and middle coxae basally brown. Remainder of hind coxa fuscous. Remainder of fore leg light brownish red; remainders of middle and hind legs brownish red. FMS with petiole fuscous; postpetiole dark brown, apical 0.4 brownish red. Basal 0.7 of T2, basal 0.4 of T3, and median areas of T5-7, dark brown-fuscous; remainder of metasoma brownish red. *Length:* 6.8 mm (6.0 mm); wing 3.8 mm (3.4 mm); 2.6 mm (2.6 mm).

MALE. *Structure:* Similar to female except genal width 0.6; propodeum with carinae stronger and higher; T2 about 2.3 as long as apical width. *Color:* Similar to female except fore and middle coxae with basal areas dark brown; middle coxae with only extreme apex whitish yellow; hind femur with basal and apical darkening; hind tibia brown, darker sub-basally and apically; T3, basal 0.5 of midlines and upper lateral areas of T5-7, dark brown. *Length:* 6.6 mm; wing 3.8 mm.

TYPE MATERIAL. Female holotype [CASC, type no. 15722], *UNITED STATES—Texas:* Hopkins Co., 22 Oct. 1939, "S. 1206; R.W.S.". Paratypes, *UNITED STATES—Texas:* 1M [OSUO], same data as for holotype; 1F [OSUO], Hunt Co., 22 Sept. 1939.

COMMENT. The females have irregular fuscous areas on the metasoma, presumably due to postmortem changes.

ETYMOLOGY. From the Latin, *longus,* long, and *cuspis,* point, in reference to the elongate ovipositor apex.

Venturia macilenta (Cresson)
(fig. 18h, 27k-l)

Campoplex macilentus Cresson, 1873. Proc. Acad. Nat. Sci. Philadelphia 1873: 384. Female (ANSP).

Venturia nitida Wahl, 1984. Contrib. American Entomol. Inst. 22: 24. New synonym.

This species can be distinguished from others of the Nigriscapus Group by the fuscous or reddish yellow ventral surface of the scape, medially arched occipital carina, presence of an apparent hypoepimeral extension, yellow fore and middle coxae, weakly granulate or smooth mesopleural surface, shape of the central area of the propodeum (fig. 18h), punctate scutellum and metapleurum, fuscous FMS with the postpetiole apex brownish red, and the fuscous midlines of T4-7. The right gonoforceps and S9 are as in figs. 27k-l.

The range of this species is from Brazil and northern Argentina to southern Arizona (Wahl, 1984).

Venturia marjoriella, new species
(figs. 7, 13d, 15g, 19s-t, 22d, 25n-o)

DIAGNOSIS. This species can be distinguished from others in the Gelechiae Group by the short to somewhat elongate areola with a granulate surface, fuscous metasoma, and presence of an areolet. The color of the fore and middle coxae varies from whitish yellow to

completely dark brown; the hind femur varies from light brownish red to dark brown.

FEMALE. *Structure:* 1. Malar space about 0.3 as long as basal mandibular width. 2. Antenna with 25-29 flagellomeres. 3. Frontal and dorsal outlines of head as in fig. 19s-t; eyes ventrally convergent; OOD about 0.9. 4. Genal width 0.4. 5. Mesosomal profile as in fig. 22d; mesonotal profile strongly produced; subalar ridge weakly rugosopunctate. 6. Pronotum with epomia strong; lateral area with weak rugae on weakly granulate surface; upper corner with sparse punctures on strongly granulate surface. 7. Mesopleurum with punctures in central region immediately below hypoepimeron about 0.1 OD, separated by 1.0-2.0 their diameter, on moderately granulate surface; scrobal groove with strong rugae from subalar ridge halfway to scrobe; hypoepimeron with punctures either sparse on dorsal and upper 0.5 of posterior margins, or completely absent. 8. Propodeum with areola ranging from about as long as wide to somewhat elongate, juncture of areola-petiolar area weakly-moderately constricted (fig. 15g); areola with few transverse rugae on granulate surface, petiolar area with fine transverse rugae; first lateral area with shallow regular punctation on granulate surface, second lateral area weakly rugosopunctate or punctate on granulate surface; propodeal neck about 0.5 as long as wide. 9. Hind femur about 5.1 as long as wide; hind tibial spur about 0.5 as long as hind basitarsus. 10. Areolet petiolate, stalk about 0.4 as long as cell. 11. FMS with petiole about 1.5 as long as postpetiole, postpetiole high (fig. 13d). 12. T2 about 2.1 as long as apical width; metasoma moderately compressed. 13. Ovipositor 2.3-3.1 as long as hind femur (see comments, below), weakly curved. *Color:* CALIFORNIA: Head and mesosoma black, the following whitish yellow: mandible except for brown of base and apex, palpi, tegula, extreme apices of coxae, trochanters except for dark brown first hind trochanter, and dorsal basal spots of middle and hind tibiae. Scape and pedicel dark brown. Coxae otherwise dark brown-fuscous. Remainder of fore and middle legs light brownish red except for brown of basal and apical 0.2, and posterior surface, of middle tibia. Hind femur, tibia, and tarsi dark brown except for lighter median area of posterior face of femur, and median 0.3 of tibia. FMS black, apex of postpetiole piceous. Apical 0.2 of T2 brownish red; remainder of metasoma dark brown-fuscous. ARIZONA AND NEW MEXICO: Similar to California specimens, except for whitish yellow of ventral surfaces of scape and pedicel, and apical 0.3 of fore coxa; hind femur and tibia lighter brown, median area of femur with brownish red hints; T4-7 with brownish red highlights. EASTERN UNITED STATES: Similar to California specimens, following areas whitish yellow: scape and pedicel ventrally, front coxa and apical 0.5 of middle coxa, extreme apex of hind coxa, trochanters except for brownish tinge of first hind trochanter, and dorsal basal spot of hind tibia. Fore and middle coxae otherwise light brownish yellow to brown. Hind coxa dark brown. Hind femur brownish red except for brown tinge of basal and apical 0.2; hind tibia brown with median 0.5 brownish red. Hind basitars with basal 0.8 whitish. *Length:* 4.4-5.6 mm (4.9 mm); wing 2.3-3.2 mm (3.1 mm); ovipositor 2.2-3.4 mm (2.5 mm).

MALE. *Structure:* Similar to female except eyes not ventrally convergent; genal width 0.5; mesopleurum with punctures separated by about their diameter; propodeum with central area narrower and carinae higher and stronger; postpetiole depressed; right gonoforceps and S9 as in figs. 25n-o. *Color:* Similar to females; California specimens with middle femur and tibia, excluding lighter color of anterior face of tibia, brown; coxae completely dark brown-fuscous; hind femur and tibia completely dark brown. Specimens from Arizona and New Mexico similar to females, except that apical margin of upper lateral 0.5 brownish red (or with highlights of that color) of T5-7. Specimens from the eastern United States similar to females, except hind femur with brownish red slightly deeper than that of fore and middle legs. *Length:* 4.5-5.3 mm; wings 2.3-3.2 mm.

TYPE MATERIAL. Female holotype [HMTC], *UNITED STATES—California:* San Diego Co., Potrero, 12 April 1974, H. & M. Townes. Paratypes, *UNITED STATES-California:* 1F [HMTC], San Diego Co., Julian, 8 May 1974, H. & M. Townes; 1F and 3mm [HMTC], 1F and 3MM [DBWC], same data as for holotype except collected 8 April 1974, 12 April 1974, 13 April 1974, and 17 April 1974.

OTHER SPECIMENS. *UNITED STATES—Arizona:* 1F [SEMC], Apache Co., White Mountains, 19 June 1950, R.H. Beamer; 1M [HMTC], Cochise Co., Douglas, 3 Sept. 1974, H. & M. Townes; 1F and 5MM [HMTC], Cochise Co., Portal, 13 Aug. 1978, 14 Aug. 1978, 17 Aug. 1978, 2 Sept. 1978, 3 Sept. 1978, 5 Sept. 1978, H. & M. Townes; 1F [USNM], Pima Co., Tuscon, 20 May 1937, R.A. Flock; *California:* 1F [CASC], Monterey Co., Santa Lucia Mountains, Junipero Serra Peak, Aug. 1956, 5000 ft., on *Quercus chrysolepsis,* H.B. Leech; 1M [CISC], San Luis Obispo Co., 2.5 mi. S. Creston, 4 May 1962, on *Rhamnus crocea,*

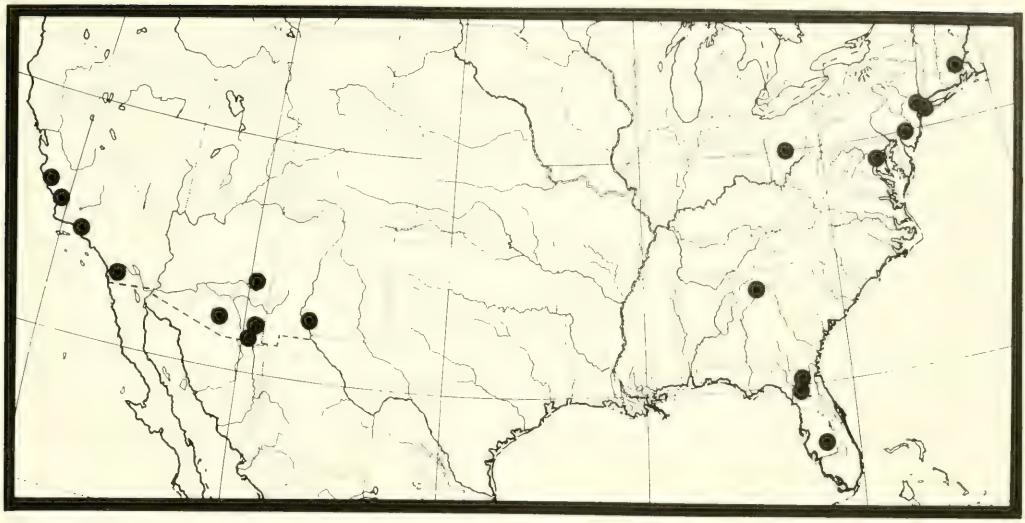

FIGURE 7. Localities of *Venturia marjoriella* Wahl.

C.A. Toschi; 1F [UCRC], Ventura Co., Saticoy, 15 March 1924, C.T. Dodds; *Florida:* 1F [FSCA], Alachua Co., Gainesville, Doyle Conner Bldg., 26 Sept. 1973, "Malaise trap", E.E. Grissell; 1F [FSCA], Gainesville, Pierce's Homestead, "S9-T10S-R18E; Malaise trap", 24 May 1976, W.H. Pierce; 1F [HMTC], Gainesville, 9 July 1981, H. & M. Townes; 1M [DBWC], Columbia and Baker Cos. Line, Osceola Nat. Forest, Jct. Rt. 90, "Malaise trap", 29 March-13 April 1977, J.R. Wiley; 1F [FSCA], Highlands Co., Archbold Biol. Sta., 17 May 1978, H.V. Weems, Jr., & L.K. Klein; 1M [FSCA], same data as before, except collected 14 May 1979 by H.V. Weems, Jr. and S. Halkin; 1M [FSCA], same collection data as before except collected 6 July 1979, H.V. Weems, Jr. and C.W. Harris; 1M [FSCA], Marion Co, 14 mi. W. Ocala, Ross Prairie, 1 Aug. 1975, "blacklight trap no. 6 in live oak hammock", P.C. Drummond; *Georgia:* 1F [CNCI], Forsyth Co., Forsyth, "Malaise trap", July 1970, F.T. Naumann; 7FF and 2MM [USNM], Sumter Co., 6 Sept. 1941, 8 Sept. 1941, 11 Sept. 1941 "1233b4; ex *Polyhymno luteostrigella*", T.L. Bissell; *Maryland:* 1F [USNM], Montgomery Co., Plummers Island, 4 Sept. 1960, K.V. Krombein; *Massachusetts:* 1F [MCZC], Middlesex Co., Holliston, 10 Aug., N. Banks; *New Jersey:* 3FF [HMTC], Burlington Co., Moorestown, 23 July 1939, H. & M. Townes; *New York:* 2FF and 3MM [HMTC], Monmouth Co., Farmingdale, 15 June 1939, 25 June 1939, 10 July 1939, 16 July 1939, 23 July 1939, H. & M. Townes; *Ohio:* 1F [HMTC], Muskingum Co., Oak Park, 5 mi. W. New Concord, 15 June 1958, C. Dasch.

COMMENT. Females from the eastern United States occasionally have the rugae of the scrobal groove extending, albeit weakly, to the scrobe. Eastern females have a range of ovipositor lengths from 2.3-2.6; specimens from the western United States have a range of 2.5-3.1. Figure 7 shows the distribution of this species.

ETYMOLOGY. This species is named for Marjorie Townes, whose work, both direct and indirect, with ichneumonids has so advanced our knowledge of this group.

Venturia masoni, new species
(figs. 14t, 18l, 21g-h, 24n, 29g-h)

DIAGNOSIS. This species may be distinguished from others in the Gelechiae Group by the predominately yellow fore and middle coxae, fuscous first hind trochanter, large and elongate areola near the basal margin of the propodeum, fuscous metasoma, and strongly curved ovipositor.

FEMALE. *Structure:* 1. Malar space about 0.4 as long as basal mandibular width. 2. Antenna with 33 flagellomeres. 3. Frontal and dorsal outlines of head as in fig. 21g-h; eyes convergent ventrally; OOD about 1.0. 4. Genal width about 0.3. 5. Mesosomal profile as in fig. 24n; mesonotal profile strongly produced; subalar ridge weakly rugosopunctate. 6. Pronotum with epomia strong; lateral area with weak to moderate rugae, on smooth surface; upper corner with scattered punctures on granulate surface. 7. Mesopleurum with punctures in central region

immediately below hypoepimeron about 0.1 OD, separated by 0.3-1.0 their diameter, on weakly granulate surface; scrobal groove with strong rugae from subalar ridge halfway to scrobe; hypoepimeron with close, fine punctures on dorsal and posterior margins. 8. Propodeum with areola elongate, juncture of areola-petiolar area moderately constricted (fig. 18l); areola with few weak rugae on granulate surface, petiolar area with strong transverse rugae on smooth surface; first lateral area with shallow scattered punctation on granulate surface, second lateral area weakly rugosopunctate on granulate surface; propodeal neck about 0.7 as long as wide. 9. Hind femur about 5.4 as long as wide; hind tibial spur about 0.5 as long as hind basitarsus. 10. Areolet petiolate, stalk about 0.4 as long as cell. 11. FMS about 1.7 as long as postpetiole (fig. 14t). 12. T2 about 2.5 as long as apical width; metasoma moderately compressed. 13. Ovipositor 2.8-2.9 as long as hind femur, strongly curved. *Color:* Head and mesosoma black, the following whitish yellow: mandible except for dark brown of base and apex, palpi, tegula, apical 0.7 of fore and middle coxae, fore and middle trochanters, and dorsal surfaces of fore and middle femora and tibia. Basal 0.3 of fore and middle coxae dark brown-fuscous. Hind coxa black. Scape with ventral surface yellowish brown. Remainder of hind leg as follows: second trochanter, dorsal basal spot of tibia, and basal 0.9 of basitarsus, whitish yellow; first trochanter, base and apex of femur, sub-basal region and apex of tibia, and remainder of tarsus, dark brown; remainder of femur and tibia brownish red. Metasoma fuscous-black except for brownish red of apicolateral corners of T2. *Length:* 6.0-6.4 mm (6.3 mm); wing 3.9-4.1 mm (4.0 mm); ovipositor 3.5-3.7 mm (3.6 mm).

MALE. *Structure:* Similar to female except antenna with 33-34 flagellomeres; eyes not convergent ventrally; genal width 0.5; propodeum with central area narrower and carinae higher and stronger; postpetiole depressed; right gonoforceps and S9 as in figs. 29g-h. *Color:* Similar to female except basal surface of scape whitish yellow; hind leg with femur, tibia, and tarsi uniformly dark brown except for sub-basal whitish yellow band of tibia; metasoma fuscous except for brownish red of apicolateral corners of T2 and basal 0.5 of T4 excepting midline. *Length:* 6.4-7.0 mm; wing 3.6-4.0 mm.

TYPE MATERIAL. Female holotype [CNCI], *MEXICO—Durango:* 3 mi. E. El Salto, 8500 ft., 10 July 1964, W.R.M. Mason. Paratypes, 1F and 4MM [CNCI], 1F and 2MM [DBWC], same data as holotype except collected 26 June 1964, 4 July 1964, 10 July 1964 and 18 July 1964.

ETYMOLOGY. This species is named after W.R.M Mason, in recognition of his contributions to the systematics of Ichneumonoidea.

Venturia mayi, new species
(figs. 14k, 14w, 19m-n, 22e)

DIAGNOSIS. This species can be distinguished from others in the Gelechiae Group by the yellow fore and middle coxae, dark brown hind femur, base of the areola being distant from the basal propodeal margin, strongly constricted juncture of the areola-petiolar area, elongate (0.8 as long as wide) propodeal neck, and fuscous metasoma except for the brownish red of the lower lateral 0.5 of T4-7.

FEMALE. *Structure:* 1. Malar space about 0.3 as long as basal mandibular width. 2. Antenna with 30-31 flagellomeres. 3. Frontal and dorsal outlines of head as in fig. 19m-n; eyes ventrally convergent; OOD about 1.0. 4. Genal width about 0.4. 5. Mesosomal profile as in fig. 22e; mesonotal profile not produced; subalar ridge weakly rugosopuncate. 6. Pronotum with epomia strong; lateral area with rugae moderate to obsolescent, on weakly granulate surface; upper corner with weak punctures separated by either about 0.3 or 0.5-1.0 their diameter, on granulate surface. 7. Mesopleurum with punctures in central region immediately below hypoepimeron about 0.1 OD, separated by 0.5-1.0 their diameter, on moderately granulate surface; scrobal groove with strong rugae from subalar ridge halfway to scrobe; hypoepimeron with sparse punctures on dorsal and posterior margins. 8. Propodeum with areola elongate, juncture of areola-petiolar strongly constricted (fig. 14w); areola granulate, petiolar area with strong transverse rugae; first lateral area with punctures absent and surface granulate, second lateral area weakly rugosopunctate on granulate surface; propodeal neck about 0.8 as long as wide. 9. Hind femur about 5.2 as long as wide; hind tibial spur about 0.5 as long as hind basitarsus. 10. Areolet petiolate, stalk about 0.4 as long as cell. 11. FMS with petiole about 1.6 as long as postpetiole (fig. 14k). 12. T2 about 2.3 as long as apical width; metasoma moderately compressed. 13. Ovipositor 2.8-2.9 as long as hind femur, moderately curved. *Color:* Head and mesosoma black, the following whitish yellow: mandible except for brown of base and apex, palpi, scape and pedicel ventrally, tegula, fore and middle coxae except for brown of extreme base, extreme apex of hind coxa, trochanters, and dorsal basal spot of hind tibia.

Remainder of fore and middle legs brownish red, either completely or with femur, and subbasal and apical bands of middle tibia, brown. Hind coxa fuscous; remainder of hind leg either fuscous or dark brown. FMS black. Basal 0.8 of T2, and midlines and upper 0.5 of T3-7, fuscous; remainder of metasoma brownish red. *Length:* 5.5-6.6 mm (5.7 mm); wing 3.2-3.6 mm (3.5 mm); ovipositor 2.9-3.6 mm (3.3 mm).

TYPE MATERIAL. Female holotype [SEMC], *MEXICO—Veracruz:* 32 km. N. Catemaco, UNAM Preserve, 5-7 Jan. 1982, "Malaise trap", E.M. May. Paratypes, *MEXICO—Veracruz:* 1F [SEMC], same data as holotype except collected 4-5 Jan. 1982; 1F [MSUC], Hueyapan, 30 Oct. 1957, R. & K. Dreisbach.

ETYMOLOGY. This species is named for Ernest M. May, the collector of the holotype.

Venturia micheneri, new species
(figs. 14c, 17g, 20q-r, 24b)

DIAGNOSIS. This species can be recognized by the rugosopunctate pronotal upper corner, yellow fore and middle coxae, brown hind trochanters, brownish red hind femur, elongate areola distant from the basal propodeal margin, granulate areola surface with weak transverse rugae, brownish red T4-7, and large size (9.1-10.4 mm).

FEMALE. *Structure:* 1. Malar space about 0.4 as long as basal mandibular width. 2. Antenna with 40-41 flagellomeres. 3. Frontal and dorsal outlines of head as in fig. 20q-r; OOD about 0.4. 4. Genal width about 0.3. 5. Mesosomal profile as in fig. 24b; mesonotal profile strongly produced; subalar ridge weakly rugosopunctate. 6. Pronotum with epomia strong; lateral area with rugae strongly developed except where weaker in central area; upper corner rugosopuncate, punctures shallow, separated by 0.3-0.5 their diameter. 7. Mesopleurum with punctures in central region immediately below hypoepimeron about 0.1 OD, separated by 0.5-1.0 their diameter, on weakly to moderately granulate surface; scrobal groove with strong rugae extending from subalar ridge to scrobe; hypoepimeron with close punctures on dorsal and posterior margins. 8. Propodeum with areola elongate, juncture of areola-petiolar areas moderately constricted (fig. 17g); areola with few weak rugae on granulate surface, petiolar area with strong transverse rugae; first lateral area with regular punctation on granulate surface, second lateral area rugosopunctate on granulate surface; propodeal neck about 0.6 as long as wide. 9. Hind femur about 5.2 as long as wide; hind tibial spur about 0.5 as long as hind basitarsus. 10. Areolet petiolate, stalk about 0.4 as long as cell. 11. FMS with petiole about 1.6 as long as postpetiole (fig. 14c). 12. T2 about 2.4 as long as apical width; metasoma moderately compressed. 13. Ovipositor 3.1-3.2 as long as hind femur, weakly curved. *Color:* Head and mesosoma black, the following yellow: mandible except for brown of base and apex, palpi, ventral surfaces of scape and pedicel, tegula, fore and middle coxae except for extreme base (or basal 0.5 of middle coxa), and apical 0.2 of hind coxa. Coxae otherwise fuscous. Fore and middle trochanters brownish yellow. Remainder of legs brownish red, except for dark brown of hind trochanters, base and apex of hind tibia, and hind tarsus. FMS black. T2 and basal 0.3 of T3, fuscous; remainder of metasoma brownish red. *Length:* 9.1-10.4 mm (10.4 mm); wing 4.9-5.4 mm (5.4 mm); ovipositor 5.3-5.9 mm (5.9 mm).

TYPE MATERIAL. Female holotype [SEMC], *UNITED STATES—Nebraska:* Chase Co., Imperial, 23 June 1982, on *Melilotus officianalis,* C.D. Michener. Paratypes, *UNITED STATES—Arizona:* 1F [UCDC], Cochise Co., 14 mi. W. Tombstone, 16 April 1965, F.D. Parker; *New Mexico:* 1F [USNM], Dona Ana Co., Las Cruces, "Ckll. 2941; on *Populus*", T.D.A. Cockerell.

COMMENT. The specimen from Las Cruces, New Mexico, has irregular brown areas on T4-7, and the basal 0.5 of T5 is fuscous. I believe these are postmortem changes.

ETYMOLOGY. This species is named for C.D. Michener, who has accidentally collected some ichneumonids along with his bees from time to time.

Venturia micraulax, new species
(figs. 1c, 2c, 8, 14g, 17k, 21q, 23h, 26g-h)

DIAGNOSIS. This species can be recognized by the pronotal upper corner having shallow regular punctures on a strongly granulate surface, yellow fore and middle coxae, brown to light brownish red hind trochanters and femur, somewhat elongate to elongate areola with a granulate surface, petiole with two weak dorsolateral grooves, and brownish red T4-7 with fuscous coloration varying from the upper 0.5 of the lateral areas to present only along the midlines of the terga.

FEMALE. *Structure:* 1. Malar space about 0.4 as long as basal mandibular width. 2. Antenna with 31-34 flagellomeres. 3. Frontal outline of head similar to fig. 20o, dorsal outline as in fig.

21q; OOD about 0.6. 4. Genal width about 0.3. 5. Mesosomal profile as in fig. 23h; mesonotal profile strongly produced; subalar ridge weakly rugosopunctate. 6. Pronotum with epomia weak and almost absent; lateral area with moderate rugae extending to lower corner; dorsal 0.5 of lateral area weakly granulate, otherwise smooth; upper corner with shallow punctures on strongly granulate surface, punctures separated by about 0.3 their diameter. 7. Mesopleurum with punctures in central region immediately below hypoepimeron about 0.1 OD, separated by 0.3-0.5 their diameter, on strongly granulate surface; scrobal groove with strong rugae from subalar ridge halfway to scrobe; hypoepimeron with sparse punctation on dorsal and posterior margins. 8. Propodeum with areola somewhat elongate to elongate, juncture of areola-petiolar area weakly constricted (fig. 17k); areola granulate, petiolar area with numerous fine transverse rugae; first lateral area granulate with numerous shallow punctures, second lateral area rugulosopunctate on granulate surface; propodeal neck about 0.6 as long as wide. 9. Hind femur about 5.1 as long as wide; hind tibial spur about 0.5 as long as hind basitarsus. 10. Areolet petiolate, stalk about 0.5 as long as cell. 11. FMS with petiole about 1.6 as long as postpetiole (fig. 14g) and with two weak dorsolateral grooves. 12. T2 about 2.0 as long as apical width; metasoma moderately compressed. 13. Ovipositor 2.6-3.1 as long as hind femur, moderately curved. *Color:* Head and mesosoma black, the following pale yellow: mandible except for dark brown of base and apex, ventral surfaces of scape and pedicel, palpi, fore and middle coxae except for dark brown of basal 0.3, fore and middle trochanters, tegula, apex of hind coxa, and dorsal spot at base of hind tibia. Remainder of fore and middle legs light brownish red. Hind leg (excluding dark brown coxa) brown, except for occasionally light brownish red of posterior face of femur and median 0.6 of tibia. FMS black. T2-3, and midlines and upper lateral areas of T4-8, dark brown-fuscous; remainder of metasoma light brownish red. *Length:* 5.1-8.6 mm (7.7 mm); wing 3.3-5.2 mm (4.4 mm); ovipositor 3.0-5.4 mm (4.4 mm).

MALE. *Structure:* Similar to female except antenna with 29-33 flagellomeres; genal width 0.5; pronotal rugae weak, absent in cental area with surface weakly granulate; propodeum with central area narrower and carinae higher and stronger; right gonoforceps and S9 as in figs. 26g-h. *Color:* Similar to female, except for metasoma: dark brown to fuscous, with amount of brownish red varying from present only on basolateral corners of T3, to all of T3 except median apical area and apices and lower lateral areas of remaining terga. *Length:* 5.2-8.0 mm; wing 3.2-4.6 mm.

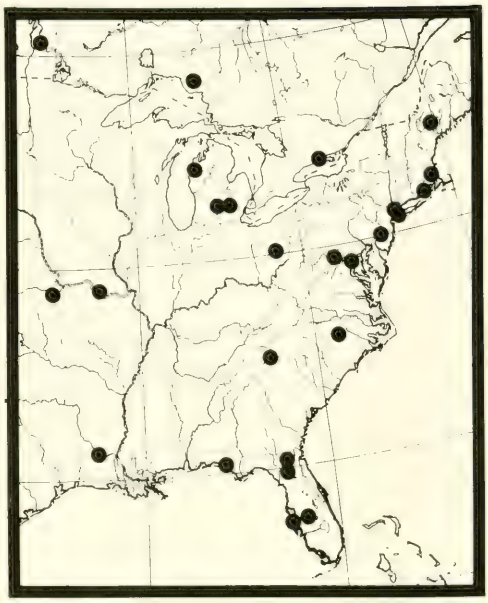

FIGURE 8. Localities of *Venturia micraulax* Wahl.

TYPE MATERIAL. Female holotype [HMTC], *UNITED STATES—Rhode Island:* Washington Co., Westerly, 1 Sept. 1936, M. Chapman. Paratypes, *UNITED STATES—District of Columbia:* 1F [USNM], 23 June 1946, D. Shappiro; *Florida:* 1M [FSCA], Alachua Co., Gainesville, Doyle Conner Bldg., 1 Aug. 1973, "Malaise trap", E.E. Grissell; 1F [FSCA], Bay Co., St. Andrews State Park, 27 Oct. 1978, "blacklight traps in sand", L. Stange; 1F [FSCA], 1F [DBWC], Columbia and Baker Cos. line, Osceola Nat. Forest, Jct. Rt. 90, 16-30 May 1977 and 13-26 April 1977, "Malaise trap", J.R. Wiley; 2MM [CNCI], Highlands Co., Archbold Biol. Sta., 26 April 1967, R.V. Peterson; 1F [FSCA], same data as preceding except coll. 25 March 1978, L. Stange; 3FF and 1M [FSCA], same data as preceding except coll. 29 March 1978, 3-4 April 1978, and 19-20 April 1978, "insect flight trap", H.V. Weems, Jr. and L.L. Lampert, Jr.; 2MM [FSCA], same data as preceeding except coll. 7 June 1979 and 23-24 June 1979, H.V. Weems, Jr., T.A. Webber and C.W. Harris; 5MM [FSCA], Sarasota Co., Myakka State Park near Sarasota, 13-15 March 1978, "flight trap in Palmetto ericaceous scrub", G.B. Fairchild; *Kansas:* 1F [DBWC], Douglas Co., Lawrence, 6

Sept. 1978, D.B. Wahl; *Maine:* 1F [HMTC], Franklin Co., Dryden, 7 Aug. 1971, H. & M. Townes; *Maryland:* 1F [DBWC], Montgomery Co., Takoma Park, 7 Aug. 1943, H. & M. Townes; *Massachusetts:* 2FF and 1M [MCZC], 1F and 1M [DBWC], Middlesex Co., Holliston, 10 July, 13 July, 18 July, 25 Aug., N. Banks; *Michigan:* 1F [MSUC], Ingham Co., 18 Sept. 1963, R. & J. Matthews; 1M [HMTC], Livingston Co., E.S. George Reserve, 20 July 1961, D. Fower; 1M [MSUC], Manistee Co., Pierport, 4 Sept. 1964, R. & J. Matthews; *Missouri:* 1F [USNM], Boone Co., Columbia, 19 Aug. 1967, "Malaise trap; 7 am-4 pm", F.D. Parker; *New Jersey:* 1F [USNM], Burlington Co., Riverton, 30 Aug. 1927, C.H. Ballou; *New York:* 5FF [HMTC], Dutchess Co., Poughkeepsie, 15 July 1936, 16 July 1936, 19 July 1936, 25 July 1936, H.K. Townes; 1F [MCZC], Nassau Co., Sea Cliff, 5-10 Sept., N. Banks; 2FF [HMTC], Nassau Co., Farmingdale, 16 July 1938 and 28 Aug. 1938, H. & M. Townes; *North Carolina:* 1M [USNM], Wake Co., Raleigh, 19 May 1946, "46-14962; on loblolly pine", W.M Kulash; *Ohio:* 1F [CEDC], Jefferson Co., Jefferson Co. State Park, 2 July 1974, "trap", J. Mills; 7FF and 3MM [CEDC], Muskingum Co., New Concord, 14 June 1964, 8 Sept. 1964, 6FF and 3MM [CEDC], Muskingum Co., New Concord, 14 June 1964, 8 Sept. 1964, 28 June 1966, 6 July 1966, 7 Sept. 1966, 25-26 Sept. 1967, 10-13 Aug. 1968, 19-22 Sept. 1968, 29-31 Aug. 1973, 1-3 Sept. 1973, "trap", C. Dasch; *Pennsylvania:* 1M [LACM], label reads "F31Pa" = Cumberland Co., Carlisle, July 1918, R.M. Fouts; 1M [USNM], Rockville [note: there are 6 towns in Pennsylvania with this name], 5 July 1909, "311", P.R. Myers; *Rhode Island:* 2FF [HMTC], Washington Co., Westerly, 25 July 1936 and 3 Sept. 1936, M. Chapman; *South Carolina:* 1F [HMTC], Greenville Co., Cleveland, 11 June 1971, G. Townes family.

OTHER SPECIMENS. *CANADA—Alberta:* 1F [CNCI], Lac La Biche, "emer. 3 Feb. 1964; F.I.S.; 63A1-665-01; ex *Herculia thymetusalis*"; *Manitoba:* 1F [CNCI], Pine Falls, 11 Oct. 1948, "F.I.S.W. 730C, ex *Herculia thymetuseta*"; *Newfoundland:* 1F [CNCI], Gambo Pond Siding—Alex Bay Dist., emerged 26 March 1954, "host *H. thymetusalis*"; *Ontario:* 13FF and 8 MM [CNCI], Black Sturgeon Lake, reared from *Picea mariana,* emerged 13 June 1962, 14 June 1962, 15 June 1962, 17 June 1962, 20 June 1962, 23 June 1962; 1F [CNCI], Brighton, 14 Sept. 1954, J.C. Martin; 2MM [CNCI], Hillsport, emerged 17 Sept. 1965, "ex *Holcocera immaculella*"; 1F [CNCI], Innisville, 12 Oct. 1963, W.R.M. Mason; 1F and 1M [CNCI], White River, emerged 13 Sept. 1965 and 17 Sept. 1964, "ex *Holcocera immaculella*".

COMMENT. Most of the specimens from Canada are in the upper part of the size range for this species, with specimens from the United States averaging about 5.5-6.5 mm in length. The mesosoma of the larger specimens is disproportionally larger in relation to the head than in smaller individuals. Color patterns and surface sculpture are the same except for a greater amount of metasomal fuscous coloration in the larger specimens. Some females have the hind leg (excluding the coxa) deep brownish-red. The postpetiole is sometimes piceous. The metasoma sometimes has the apicolateral areas of T2-3, and all of the lateral areas of T4-8, light brownish red. Figure 8 shows the distribution of this species.

ETYMOLOGY. From the Greek *mikros,* small, and *aulax,* furrow, in reference to the two weak lateral grooves of the dorsal surface of the petiole.

Venturia mulleola, new species
(figs. 13f, 15k, 19y-z, 22a)

DIAGNOSIS. Similar to other small species with roundish heads, parallel inner ventral margins of the compound eyes, and sparsely punctate pronotal upper corners; it can be distinguished by the deep brownish red mesosoma, lack of pronotal rugae, yellow fore and middle coxae, somewhat elongate and granulate areola, stout FMS with depressed postpetiole, and dark brown metasoma with lower lateral areas of T4-7 brownish red.

FEMALE. *Structure:* 1. Malar space about 0.4 as long as basal mandibular width. 2. Antenna with 29 flagellomeres. 3. Frontal and dorsal outlines of head as in fig. 19y-z; OOD about 0.8. 4. Genal width about 0.3. 5. Mesosomal profile as in fig. 22a; mesonotal profile strongly produced; subalar ridge weakly rugosopunctate. 6. Pronotum with epomia absent; lateral area with rugae absent, surface granulate; upper corner with few punctures on strongly granulate surface; collar granulate. 7. Mesopleurum with punctures in central region immediately below hypoepimeron about 0.1 OD, separated by 1.0-2.0 their diameter, on strongly granulate surface; scrobal groove with fine rugae from subalar ridge to 0.6 of distance to scrobe; hypoepimeron with few punctures on dorsal and posterior margins. 8. Propodeum with areola somewhat elongate, juncture of areola-petiolar area moderately constricted (fig. 15k); areola strongly granulate, petiolar area with fine trans-

verse rugae on granulate surface; first and second lateral areas with sparse weak punctures on granulate surface; propodeal neck about 0.5 as long as wide. 9. Hind femur about 4.2 as long as wide; hind tibial spur about 0.5 as long as hind basitarsus. 10. Areolet petiolate, about 0.5 as long as cell. 11. FMS with petiole about 1.6 as long as postpetiole (fig. 13f). 12. T2 about 1.9 as long as apical width; metasoma moderately compressed. 13. Ovipositor about 2.8-2.9 as long as hind femur, weakly curved. *Color:* Head and mesosoma deep brownish red-piceous, the following whitish yellow: mandible except for brown of base and apex, palpi, scape and pedicel ventrally, tegula, apical 0.7 of fore and middle coxae, extreme apex of hind coxa, fore and middle trochanters, and dorsal basal spots of tibiae. Fore and middle coxae otherwise brownish yellow. Remainder of fore and middle legs light brownish red. Hind trochanters and remainder of hind coxa brown. Hind femur except for basal and apical 0.1-0.2, and median 0.3 of tibia, brownish red; remainder of femur, tibia, and tarsi, brown. Metasoma deep brownish red except for ventral 0.3 of lateral areas of T4-6. *Length:* 4.9 mm (4.7 mm); wing 3.1 (3.1 mm); ovipositor 2.7 mm (2.7 mm).

TYPE MATERIAL. Female holotype [HMTC], *UNITED STATES—South Carolina:* Greenville Co., Cleveland, 12 June 1961, G.F. Townes. Paratype [HMTC], same data as for holotype except collected 25 May 1961.

ETYMOLOGY. From the Latin *mulleolus,* in reference to the reddish color of the mesosoma.

Venturia musae Wahl
(fig. 18g)

Venturia musae Wahl, 1984. Contrib. American Entomol. Inst. 22: 13. Female (HMTC).

Distinguishable from other species in the Nigriscapus Group by the yellow ventral surface of the scape, medially arched occipital carina, lack of an apparent hypoepimeral extension, yellow fore and middle coxae, coarse mesopleural punctation on a strongly granulate surface, weak median and lateral longitudinal carinae of the propodeum (fig. 18g), coarsely rugosopunctate scutellum and metapleurum, and brownish red FMS.

This species is found in Mexico (Veracruz) and Guatemala.

Venturia nickelseni, new species
(figs. 14l, 16g, 21n, 23n)

DIAGNOSIS. Distinguishable from other species with a completely fuscous metasoma by the rugosopunctate pronotal upper corner, moderately granulate mesopleurum, predominately dark brown coxae, brown first hind trochanter and hind femur, short areola with the surface granulate, and the moderately curved ovipositor.

FEMALE. *Structure:* 1. Malar space about 0.4 as long as basal mandibular width. 2. (Antennae incomplete). 3. Frontal outline of head similar to fig. 20o, dorsal outline as in fig. 21n; OOD about 0.9. 5. Mesosomal profile as in fig. 23n; mesonotal profile strongly produced; subalar ridge weakly rugosopunctate. 6. Pronotum with epomia strong; lateral area with strong rugae on smooth surface, some rugae intruding into upper corner; upper corner rugosopunctate on granulate surface, punctures separated by about 0.3 their diameter. 7. Mesopleurum with punctures in central region immediatley below hypoepimeron about 0.1 OD, separated by 0.3-0.5 their diameter, on moderately granulate surface; scrobal groove with strong rugae from subalar ridge halfway to scrobe; hypoepimeron with sparse punctures on dorsal and posterior margins. 8. Propodeum with areola as long as wide, juncture of areola-petiolar area weakly constricted (fig. 16g); areola with granulate surface, petiolar area with weak reticulate rugae on granulate surface; first lateral area with sparse punctures on granulate surface, second lateral area rugosopunctate on granulate surface; propodeal neck about 0.6 as long as wide. 9. Hind femur about 5.0 as long as wide; hind tibial spur about 0.5 as long as hind basitarsus. 10. Areolet petiolate, stalk about 0.3 as long as cell. 11. FMS with petiole about 1.6 as long as postpetiole (fig. 14l). 12. T2 about 1.7 as long as apical width; metasoma moderately compressed. 13. Ovipositor about 2.8 as long as hind femur, weakly curved; apical notch almost absent. *Color:* Head and mesosoma black, the following whitish yellow: mandibles except for brown of base and apex, palpi, scape ventrally, tegula, apical 0.3 of fore and middle coxae, and trochanters except for dark brown of second hind trochanter. Remainder of fore and mid legs brownish red. Coxae otherwise dark brown-fuscous. Remainder of hind leg with femur and tibia dark brown, except for lighter median 0.5 of tibia; hind tarsi brown. FMS black; T2-7 fuscous. *Length:* 6.4 mm; wing 4.0 mm; ovipositor 3.3 mm.

TYPE MATERIAL. Female holotype [LACM], *UNITED STATES—California:* Santa Barbara Co., Summerland, 26 April 1971, C.W. Kirkwood.

ETYMOLOGY. This species is named for

John W. Nickelsen, an economic entomologist who has done much to promote rational pest control methods in California.

Venturia nigricoxalis (Cushman)
(figs. 9, 14a, 16i, 20g-h, 24d, 28e-f)

Idechthis nigricoxalis Cushman, 1915. Proc. United States Nat. Mus. 48: 512. Male (USNM).

DIAGNOSIS. This species can be distinguished by the rugosopunctate pronotal upper corner, fuscous fore and middle coxae, brown trochanters and femora, elongate areola distant from the basal propodeal margin, moderately constricted juncture of the areola-petiolar area, brownish red T4-7, long ovipositor (3.5-3.8 as long as hind femur), and large size (8.4-11.4 mm).

FEMALE. *Structure:* 1. Malar space about 0.4 as long as basal mandibular width. 2. Antenna with 35-38 flagellomeres. 3. Frontal and dorsal outlines of head as in fig. 20g-h; OOD about 0.7. 4. Genal width about 0.3. 5. Mesosomal profile as in fig. 24d; mesonotal profile strongly produced; subalar ridge weakly rugosopunctate. 6. Pronotum with strong epomia; lateral area with rugae strong and extending to lower corner, on smooth surface; upper corner rugosopunctate, punctures separated by about 0.3 their diameter. 7. Mesopleurum with punctures in central region immediately below hypoepimeron about 0.2 OD, separated by 0.3-0.5 their diameter, on weakly granulate surface; scrobal groove with strong rugae extending from subalar ridge to scrobe; hypoepimeron with close, well-defined punctures on dorsal and posterior margins. 8. Propodeum with areola elongate, juncture of areola-petiolar area moderately constricted (fig. 16i); areola with weak transverse rugae on smooth surface, petiolar area reticulostriate; first lateral area with few shallow punctures on granulate surface, second lateral area coarsely rugosopunctate on weakly granulate surface; propodeal neck about 0.6 as long as wide. 9. Hind femur about 5.5 as long as wide; hind tibial spur about 0.5 as long as hind basitarsus. 10. Areolet petiolate, stalk 0.5 as long as cell. 11. FMS with petiole about 1.6 as long as postpetiole, postpetiole depressed (fig. 14a); S1 with median 0.4 usually with two long shallow grooves. 12. T2 about 2.1 as long as apical width; metasoma moderately compressed. 13. Ovipositor 3.5-3.8 as long as hind femur, moderately curved. *Color:* Head and mesosoma black, the following dark brown: mandible, scape, pedicel, tegula, legs except for brownish red of fore and middle femora and tibiae and brownish yellow dorsum of fore tibia. Palpi brownish yellow. FMS black; T2 and basal 0.4 of T3, dark brown; remainder of metasoma brownish red. *Length:* 8.4-11.4 mm (9.7 mm); wing 5.2-6.7 mm (5.4 mm); ovipositor 5.7-7.5 mm (6.0 mm).

MALE. *Structure:* Similar to female except antenna with 33-37 flagellomeres, mesopleural punctures about 0.1 OD and separated by about their diameter, petiole more slender, propodeum with central area narrower and carinae stronger and higher; right gonoforceps and S9 as in figs. 28e-f. *Color:* As in female, except scape and pedicel ventrally brownish red; fore and middle coxae fuscous; T3 dark brown. *Length:* 8.4-11.6 mm,; wing 4.6-7.0 mm.

SPECIMENS EXAMINED. Female holotype (USNM, type no. 18354), *UNITED STATES—New York:* Niagara Co., Youngstown, 31 July 1905, "Quaintance no. 574", F. Johnson. Allotype (USNM, type no. 18354), *UNITED STATES—Virginia:* Fairfax Co., Vienna, 11 Aug.1913, "Quaintance no. 7966", reared by R.A. Cushman. Paratypes, *UNITED STATES—Georgia:* 1F [USNM], type no. 18354, Peach Co., Ft. Valley, 6 Aug. 1905, "Quaintance no. 407", J.H. Beattie; *Ohio:* 1M [USNM], type no. 18354, Ottawa Co., Lakeside, "on peach; Quaintance no. 5626", H.F. Wilson. Other specimens, *CANADA—Ontario:* 1M [DBWC], Ancaster, 1 Sept. 1959, J.E.H. Martin, *UNITED STATES—Alabama:* 1M [CASC], Pike Co., 8 mi. W. Brundidge, 11 July 1953, E.S. Ross; *Arkansas:* 1M [USNM], Logan Co., Sept. 1965, "bred from lesser peach

FIGURE 9. Localities of *Venturia nigricoxalis* (Cush.).

tree borer''; *Florida:* 1F [CNCI], Gasden Co., Tallahassee, Tall Timber Res. Sta., 16 May 1968, G. Heinrich; *Georgia:* 1F [FSCA], Clarke Co., Athens, Whitehall Preserve, 2 May 1979, ''insect flight trap'', R.H. Turnbow, Jr.; 3FF [CNCI], Forsyth Co., Forsyth, 18-23 May 1970 and July 1970, ''Malaise trap'', F. Naumann; 1M [USNM], Peach Co., Ft. Valley, 31 May 1905, ''on peach'', J.H. Beattie; *Indiana:* 2FF and 1M [USNM], Knox Co., 3 May 1967 and 5 May 1967, ''peach wood'', R. Dolphin; 1F [USNM], Knox Co., coll. by McCleveland, May 1963, ''Peach Wood Insectary''; *Maryland:* 2FF and 2MM [HMTC], Montgomery Co., Takoma Park, 4 July 1942, H. & M. Townes; Prince Georges Co., Adelphi, 26 March 1968, ''in house'', E. Hodges; *Michigan:* 1F [USNM], Allegan Co., Douglas, ''Quaintance no. 5926'', coll. by Brancher; 1M [MSUC], Kalamazoo Co., Gull Lake Biol. Sta., 27 July 1965, G.C. Eickwort; *New Jersey:* 1M [USNM], Gloucester Co., June 1930, ''reared from *Euzophora* sp.''; 1M [USNM], Bergen Co., Hackensack, 7 April 1926, ''reared from *Euzophora semifuneralis*''; *New York:* 1F [USNM], Queens Co., Woodhaven, 20 May 1919, ''ex *Synanthedon acerni*'', G.P. Englehardt; 1M [HMTC], Westchester Co., Scarsdale, 18 June 1957, G.R. Ferguson; *Ohio:* 1F [OSUC], Montgomery Co., 18 Aug. 1943, F.D. DeGant; *Pennsylvania:* 1F [USNM] and 1M [MCZC], no locality, coll. by F.E. Melsheimer; 1M [USNM], Dauphin Co., Harrisburg, 13 June 1908, P.R. Myers; *South Carolina:* 2FF [USNM], York Co., Rock Hill, reared 25 May 1913 and 3 June 1913, ''in bark of tulip from *Euzophora ostricolorella*'', ''11147b Hopk.U.S.'' and ''11147d Hopk.U.S.'', C. Heinrich; *Virginia:* 1F [USNM], Arlington Co., Glencarlyn, reared 17 Oct. 1913, ''par. of Euzophora ostricolorella; 11147H—Hopk. U.S.'', C. Heinrich; 3FF and 1M [USNM], Winchester, 5 May 1919 and 16 May 1919, ''bred from *E. semifuneralis;* Quaintance no. 1402'', E.B. Blakeslee; *West Virginia:* 2FF [USNM], 1F [HMTC], 1M [USNM], 1M [HMTC], Jefferson Co., Kearneysville, 26 May 1939, 25 July 1939, 1 Aug. 1939, ''biological orchard''.

COMMENT. In males, T5-7 occasionally have the basal 0.3 and midlines brown. One male (Harrisburg, PA) has the apices of the postpetiole and T2 brownish red, and only the basal 0.3 of T3 dark brown.

Hope and Pless (1979) discuss the biology of *V. nigricoxalis* in relation to *Euzophora ostricolorella.* Figure 9 shows the distribution of this species.

Venturia nigriscapus (Viereck)
(figs. 3k, 3n, 10, 18f, 27i-j)

Idechthis nigriscapus Viereck, 1921. Psyche 28: 77. Female (MCZC).

Idechthis mimicus Viereck, 1926. Proc. and Trans. Roy. Soc. Canada (3) 20 (5): 185. Male (CNCI).

Venturia sp. D, Finlayson, 1975. Mem. Entomol. Soc. Canada 94: 25.

V. nigriscapus was redescribed by Wahl (1984). It can be distinguished from other species of the Nigriscapus Group by the fuscous ventral surface of the scape, medially straight occipital carina, lack of an apparent hypoepimeral extension, strongly granulate mesopleurum, strong propodeal carinae, black FMS with the apex of the postpetiole brownish red, and coarsely rugosopunctate scutellum and metapleurum. The right gonoforceps and S9 are as in figs. 28e-f. Most North American specimens have the basal 0.5 of the fore and middle coxae yellow, and the middle and hind femora brownish red. Specimens with fuscous coxae from the northeastern United States, southeastern Canada, and Mexico also have the middle and hind femora brown.

In addition to the specimens from Oaxaca reported earlier (Wahl, 1984), I have recently examined two additional Mexican specimens: *Puebla:* 1M [SEMC], 6 mi. E. Huauchinango, 21 Aug. 1962, 4050 ft., Univ. Kansas Mexican Expedition; *Veracruz:* 1F [SEMC], Rio Jamapa, NE of Coscomatepec, 8 Aug. 1969, 4300 ft., Univ. Kansas Mexican Expedition. Fig. 10 shows the distribution of this species.

Venturia platyura, new species
(figs. 3c, 14i, 17h, 21l, 23l, 25l-m)

DIAGNOSIS. Recognizable by the pronotal upper corner being rugosopunctate on a granulate surface, apically yellow fore and middle coxae, brown-brownish red hind coxa with the apical 0.3 whitish yellow, elongate areola with a granulate surface, depressed postpetiole, weakly compressed metasoma, brownish red T4-7 (except for a few fuscous spots on the midlines), and strongly curved and laterally compressed ovipositor.

FEMALE. *Structure:* 1. Malar space about 0.4 as long as basal mandibular width. 2. Antenna with 36-39 flagellomeres. 3. Frontal outline of head similar to fig. 20o, dorsal outline as in fig. 21l; OOD about 0.7. 4. Genal width about 0.4. 5. Mesosomal profile as in fig. 23l; mesonotal

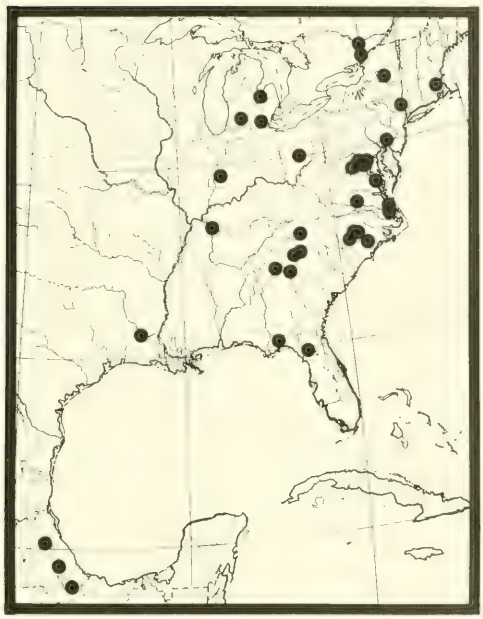

FIGURE 10. Localities of *Venturia nigriscapus* (Vier.).

profile strongly produced; subalar ridge weakly rugosopunctate. 6. Pronotum with strong epomia; lateral area with strong rugae except where absent adjacent to front edge, on weakly granulate surface; upper corner rugosopunctate, punctures separated by about 0.3 (or occas. confluent) their diameter, surface strongly granulate. 7. Mesopleurum with punctures in central region immediately below hypoepimeron about 0.1 OD, separated by 0.5-1.0 their diameter, on moderately granulate surface; scrobal groove with strong rugae extending from subalar ridge to near scrobe; hypoepimeron with close, well-defined punctures on dorsal and posterior margins. 8. Propodeum with areola elongate, juncture of areola-petiolar area strongly constricted (fig. 17h); areola with few weak rugae on strongly granulate surface, petiolar area with transverse rugae on granulate surface; first lateral area with shallow punctures on granulate surface, second lateral area rugosopunctate on smooth surface; propodeal neck about 0.6 as long as wide. 9. Hind femur about 5.0 as long as wide; hind tibial spurs about 0.5 as long as hind basitarsus. 10. Areolet petiolate, stalk about as long as cell. 11. FMS with petiole about 1.7 as long as postpetiole, postpetiole low (fig. 14i). 12. T2 about 1.6 as long as apical width; metasoma weakly compressed. 13. Ovipositor 2.6-2.8 as long as hind femur, weakly curved and strongly laterally compressed. *Color:* Head and mesosoma black, the following whitish yellow: mandible except for brown of base and apex, palpi, ventral surfaces of scape and pedicel, tegula, fore and middle coxae except for dark brown of extreme base, apical 0.3 of hind coxa, trochanters except for light brown of first hind trochanter, and dorsal surfaces of fore and middle tibia. Remainder of fore and middle legs light brownish red. Hind coxa with basal 0.7 centrally dark brown, surrounded by brownish red; remainder of hind leg brownish red, except for darker sub-basal and apical bands of tibia, and darker apices of tarsomeres. FMS with petiole fuscous, postpetiole ranging from fuscous to deep brownish red with apex lighter. Basal 0.8 of T2, basal 0.2-0.3 of T3, and midlines (usually) of T5-7, dark brown-fuscous; remainder of metasoma brownish red. *Length:* 5.9-9.9 mm (7.7 mm); wing 3.2-5.4 mm (4.4 mm); ovipositor 3.2-4.9 mm (4.1 mm).

MALE. *Structure:* Similar to female except antenna with 35-39 flagellomeres; genal width about 0.5.; propodeum with carinae higher and stronger, areola with transverse rugae and juncture of areola-petiolar area more strongly constricted; right gonoforceps and S9 as in figs. 25l-m. *Color:* Similar to female, except legs with femora, tibia and tarsi light brownish red except for brown hind tarsi; hind coxa with basal 0.7 dark brown; T3, basal 0.5 of midlines and upper lateral areas of T5-7, dark brown; gonoforceps brownish red. *Length:* 6.0-8.0 mm; wing 3.4-4.7 mm.

TYPE MATERIAL. Female holotype [SEMC], *UNITED STATES—Texas:* Matagorda Co., 4 May 1953, L.D. Beamer. Paratypes, *UNITED STATES—Florida:* 1F and 2MM [FSCA], Alachua Co., Gainesville, Pine Hill Estates, "Malaise trap", H.V. Weems, Jr.; 1M [DBWC], Columbia and Baker Cos. line, Osceola Nat. Forest at junct. of Rt. 90, 13-26 April 1977, "Malaise trap", J.R. Wiley; 1F [FSCA], Highlands Co., Archbold Biol. Sta., 2-4 Feb 1979, "insect flight trap", H.V. Weems, Jr. and S.Halkin; 1F [CNCI], Manatee Co., Onaco, 29 March 1965, J.C. Martin; 3FF and 2MM [FSCA], 1M [DBWC], Marion Co., 9 mi. SSW Ocala, 13 Oct.-5 Nov. 1975, "Malaise trap in turkey oak", J. Wiley; 1F [CASC], Putnam Co., Crescent City, April 1908, M.C. Van Duzee; 1F [DBWC], Putnam Co., 2 mi. NW Orange Springs, 22 Oct. 1975, "blacklight trap", D. Bowman; *Missouri:* 1M [HMTC], Taney Co., 13 July 1975, S. & J. Peck; *South Carolina* or *Florida:* 1F and 1M

[USNM], no other data, 15 May, "ex *Platoceticus gloveri*," F.M. Jones.

COMMENT. In females, the basal 0.7 of the hind coxa can be completely dark brown. A female specimen from Mexico (*Sinaloa:* 20 mi. E. Concordia, 3000', 8 Aug. 1964, W.R.M. Mason [CNCI]) resembles the typical female of this species except for a shorter propodeal neck (0.4 as long as wide) and the presence of a weak nodus on the ovipositor apex just before the dorsal subapical notch (as in *V. eremna*).

ETYMOLOGY. From the Greek *platy,* flat, and *oura,* tail, in reference to the laterally compressed ovipositor.

Venturia portalensis, new species
(figs. 3e, 3j, 14j, 16f, 21k, 23e, 26k-l)

DIAGNOSIS. This species can be distinguished by the rugosopunctate pronotal upper corner, yellow fore and middle coxae, yellow hind trochanters, closely punctate (punctures separated by about 0.3-0.5 their diameter) mesopleurum, elongate areola distant from the basal propodeal margin, strongly constricted juncture of the areola-petiolar area, high postpetiole, brownish red T4-7, and rather short (2.4-2.6 as long as hind femur) ovipositor.

FEMALE. *Structure:* 1. Malar space about 0.4 as long as basal mandibular width. 2. Antenna with 36-39 flagellomeres. 3. Frontal outline of head similar to fig. 20o, dorsal outline as in fig. 21k; OOD about 0.9. 4. Genal width about 0.4. 5. Mesosomal profile as in fig. 23e; mesonotal profile strongly produced; subalar ridge weakly rugosopunctate. 6. Pronotum with epomia strong; lateral area with strong rugae on smooth surface; upper corner rugosopunctate, punctures separated by about 0.3 their diameter. 7. Mesopleurum with punctures in central region immediately below hypoepimeron about 0.1 OD, separated by 0.3-0.5 their diameter, on moderately granulate surface; scrobal groove with strong rugae which become obsolescent near scrobe; hypoepimeron with punctures on dorsal and upper 0.5 of posterior margins. 8. Propodeum with areola elongate, juncture of areola-petiolar area strongly constricted (fig. 16f); areola with weak rugae on weakly granulate surface, petiolar area with strong transverse rugae on smooth surface; first lateral area with regular punctation on granulate surface, second lateral area centrally with punctures on weakly granulate surface, rugulose toward edges; carinae forming second lateral area often irregular in height and outline; propodeal neck about 0.5 as long as wide. 9. Hind femur about 5.2 as long as wide; hind tibial spur about 0.5 as long as hind basitarsus. 10. Areolet petiolate, stalk about 0.5 as long as cell. 11. FMS with petiole about 1.7 as long as postpetiole, postpetiole high (fig. 14j). 12. T2 about 2.2 as long as apical width; metasoma moderately commpressed. 13. Ovipositor 2.4-2.6 as long as hind femur, moderately curved. *Color:* Head and metasoma black, the following whitish yellow: mandible except for brown of base and apex, palpi, ventral surfaces of scape and pedicel, tegula, fore and middle coxae except for extreme base, apical 0.2 of hind coxa, trochanters except for faint brownish tinge of posterior face of first hind trochanter, dorsal surface of front tibia, and dorsal basal spot of hind tibia. Remainder of fore and middle legs light brownish red. Hind coxa fuscous except as noted. Remainder of hind leg light brownish red, except for brown of sub-basal region and apical 0.3 of tibia, and apices of tarsomeres. FMS black except for brownish red of apical 0.2 of postpetiole. Basal 0.7 of T2 and basal 0.3 of T3, fuscous; metasoma otherwise light brownish red. *Length:* 7.1-8.6 mm (7.4 mm); wing 3.9-4.6 mm (4.3 mm); ovipositor 3.1-4.0 mm (3.9 mm).

MALE. *Structure:* Similar to female except antenna with 37-39 flagellomeres; genal width about 0.5; propodeum with carinae higher and stronger; areola and petiolar area separated by strong transverse carina; right gonoforceps and S9 as in figs. 26k-l. *Color:* Similar to female except brown of first hind trochanter more pronounced; base and apex of hind femur brown; hind tibia and tarsus dark brown except for lighter median area of tibia; basal 0.9 of T2, T3, median basal 0.3-0.8 of tergum 5, basal 0.8-0.9 of T6-7, and gonoforceps, fuscous to dark brown. *Length:* 7.1-8.6 mm; wing 4.3-4.9 mm.

TYPE MATERIAL. Female holotype [HMTC], *UNITED STATES—Arizona:* Cochise Co., Portal, 17 Aug. 1974, H. & M. Townes. Paratypes, *UNITED STATES—Arizona:* 1F [DBWC], Cochise Co., Southwest Research Station, 5 mi. W. Portal, 5400 ft., 31 July 1965; 11FF and 26MM [HMTC], 1F and 2MM [DBWC], same data as holotype except collected on following dates in 1974: 10 Aug., 11 Aug., 12 Aug., 13 Aug., 15 Aug., 16 Aug., 17 Aug., 18 Aug., 20 Aug., 22 Aug., 24 Aug., 31 Aug., 1 Sept., 5 Sept.; *Texas:* 1F and 3MM [HMTC], 1F [DBWC], Culberson Co., McKittrick Canyon, 5200 ft., 15 Aug. 1961, 16 Aug. 1961, 17 Aug. 1961, 19 Aug. 1961.

COMMENT. Males sometimes have the hind femur almost completely brown with only a small median area brownish red.

ETYMOLOGY. The specific name is derived from that of the type locality in Arizona.

Venturia prolixa, new species
(figs. 14m, 17d, 21s, 23c)

DIAGNOSIS. This species can be recognized by the rugosopunctate pronotal upper corner, elongate mesosoma (fig. 23c), yellow fore and middle coxae, light brown hind trochanter, elongate (9.1 as long as wide) hind femur, elongate and sharply pointed areola near the basal propodeal margin, elongate FMS with depressed postpetiole, brownish red T4-7, and large size (10.5-11.6 mm).

FEMALE. *Structure:* 1. Malar space about 0.3 as long as basal mandibular width. 2. Antenna with 44 flagellomeres. 3. Frontal outline of head similar to fig. 20o, dorsal outline as in fig. 21s; OOD about 0.5. 4. Genal width about 0.3. 5. Mesosomal profile as in fig. 23c; mesonotal profile strongly produced; subalar ridge weakly rugosopunctate. 6. Pronotum with epomia strong; lateral area with rugae weak or obsolescent, strong only in lower corner, on weakly granulate surface; upper corner weakly rugosopunctate on granulate surface, punctures separated by about 0.3 their diameter. 7. Mesopleurum with punctures in central region immediately below hypoepimeron about 0.1 OD, separated by 0.3-0.5 their diameter, on strongly granulate surface; scrobal groove with fine rugae from subalar ridge to near scrobe; hypoepimeron with close punctures on dorsal and posterior margins. 8. Propodeum with areola elongate, juncture of areola-petiolar area weakly constricted (fig. 17d); areola with fine transverse rugae on granulate surface, petiolar area with strong transverse rugae on smooth surface; first lateral area with shallow punctures on strongly granulate surface, second lateral area weakly rugosopunctate on strongly granulate surface; propodeal neck about 0.7 as long as wide. 9. Hind femur about 9.1 as long as wide; hind tibial spur about 0.3 as long as hind basitarsus. 10. Areolet petiolate, stalk about 0.4 as long as cell. 11. FMS with petiole about 1.4 as long as postpetiole, postpetiole depressed (fig. 14m); S1 with weak longitudinal wrinkles. 12. T2 about 3.0 as long as apical width; metasoma moderately compressed. 13. Ovipositor 2.6-2.7 as long as hind femur, almost straight (note that femur is unusually long and that ovipositor is really about length of that of *erythropus*). *Color:* Head and mesosoma black, the following whitish yellow: mandible except for brown of base and apex, palpi, ventral surfaces of scape and pedicel, tegula, fore and middle trochanters, and dorsal surfaces of fore and middle tibia. Hind coxa dark brown, apical 0.2 brownish yellow. Remainder of legs light brownish red. FMS with petiole fuscous, postpetiole deep brownish red to piceous, apex lighter; basal 0.7 dark brown, remainder of metasoma brownish red. *Length:* 11.6 mm (10.5 mm); wing 7.2 mm (6.9 mm); ovipositor 6.2 mm (5.9 mm).

TYPE MATERIAL. Female holotype [CNCI], *UNITED STATES—Texas:* Jeff Davis Co., Ft. Davis, 24 May 1959, 5000 ft., W.R.M. Mason. Paratype, *UNITED STATES—Utah:* 1F [USNM], Sevier Co., Richfield, 15 Aug. 1930, "light trap".

ETYMOLOGY. From the Latin *prolixus,* stretched out or long, in reference to the long legs.

Venturia pullata, new species
(figs. 13j, 14x, 19g-h, 23a)

DIAGNOSIS. Similar to other small species with roundish heads, parallel inner ventral margins of the compound eyes, and sparsely punctate pronotal upper corners; it can be distinguished by the weak pronotal rugae, mesopleural punctures separated by 1.0-2.0 their diameter, elongate areola with the juncture of the areola-petiolar area strongly constricted, dark brown hind femur, and fuscous coxae and metasoma.

FEMALE. *Structure:* 1. Malar space about 0.3 as long as basal mandibular width. 2. Antenna with 29 flagellomeres. 3. Frontal and dorsal outlines of head as in fig. 19g-h; OOD about 0.8. 4. Genal width about 0.3. 5. Mesosomal profile as in fig. 23a; mesonotal profile strongly produced; subalar ridge weakly rugosopunctate. 6. Pronotum with epomia strong; lateral area with rugae weak except where absent adjacent to front edge; upper corner with sparse punctures on moderately granulate surface; collar smooth. 7. Mesopleurum with punctures in central region immediately below hypoepimeron about 0.1 OD, separated by about their diameter, on weakly-moderately granulate surface; scrobal groove with strong rugae from subalar ridge halfway to scrobe; hypoepimeron with punctures absent on dorsal and posterior margins. 8. Propodeum with areola elongate, juncture of areola-petiolar area strongly constricted (fig. 14x); areola granulate, petiolar area with fine transverse rugae on granulate surface; first lateral area with regular punctation on granulate surface, second lateral area with shallow regular punctation on granulate surface, and with rugae present along margins;

propodeal neck about 0.5 as long as wide. 9. Hind femur about 5.7 as long as wide; hind tibial spur about 0.5 as long as hind basitarsus. 10. Areolet petiolate, stalk about 0.3 as long as cell. 11. FMS with petiole about 1.6 as long as postpetiole, postpetiole high (fig. 13j). 12. T2 about 2.4 as long as apical width; metasoma moderately compressed. 13. Ovipositor about 2.8 as long as hind femur, weakly curved. *Color:* Head and mesosoma black, the following whitish yellow: mandible except for brown of base and apex, palpi, scape ventrally, tegula, extreme apices of coxae, trochanters except for dark brown first hind trochanter, and dorsal basal spots of middle and hind tibiae. Coxae otherwise dark brown-fuscous. Remainder of fore and middle legs brownish red except for darker sub-basal and apical bands of middle tibia. Remainder of hind leg dark brown except for lighter color of tarsi and median 0.4 of tibia. Metasoma fuscous except for brownish red extreme apex of T2. *Length:* 6.2 mm (6.1 mm); wing 3.9 mm (3.9 mm); ovipositor 3.5 mm (3.4 mm).

TYPE MATERIAL. Female holotype [HMTC], *UNITED STATES—Colorado:* Boulder Co., Lyons, 14 June 1948, H., M., G., & D. Townes. Paratype female [HMTC], same data as for holotype.

ETYMOLOGY. From the Latin *pullatus,* clothed in dark garments, in reference to the overall dark coloration.

Venturia pumila, new species
(figs. 13e, 15j, 19c-d, 22l)

DIAGNOSIS. Similar to other small species with roundish heads, parallel inner ventral margins of the compound eyes, and sparsely punctate pronotal upper corners; it can be distinguished by the lack of rugae on the lateral area of the pronotum, lack of an areolet, strongly constricted juncture of the areola-petiolar area, dark brown metasoma with the lower lateral 0.5 of T4-7 brownish red, and small size (4.3 mm).

FEMALE. *Structure:* 1. Malar space about 0.3 as long as basal mandibular width. 2. (Antennae incomplete). 3. Frontal and dorsal outlines of head as in fig. 19c-d; OOD about 0.7. 4. Genal width about 0.3. 5. Mesosomal profile as in fig. 22l; mesonotal profile strongly produced; subalar ridge weakly rugosopunctate. 6. Pronotum with epomia absent; lateral area with rugae absent except on posterior edge of lower corner, surface smooth and impunctate; upper corner with sparse punctures on weakly granulate surface; collar smooth. 7. Mesopleurum with punctures in central region immediately below hypoepimeron about 0.1 OD, separated by 0.5-1.0 their diameter, on strongly granulate surface; scrobal groove with strong rugae from subalar ridge at least halfway to scrobe (area destroyed by being transversely mounted on minuten pin); hypoepimeron with punctures absent on dorsal and posterior surfaces. 8. Propodeum with areola elongate; juncture of areola-petiolar area strongly constricted (fig. 15j); areola with fine rugae and several large punctures on weakly granulate surface, petiolar area reticulostriate; first lateral area with shallow regular punctures on granulate surface, second lateral area weakly rugosopunctate on granulate surface; propodeal neck about 0.6 as long as wide. 9. Hind femur about 4.3 as long as wide; hind tibial spur about 0.5 as long as hind basitarsus. 10. Areolet absent. 11. FMS with petiole about 1.7 as long as postpetiole, postpetiole depressed (fig. 13e). 12. T2 about 1.8 as long as apical width; metasoma moderately compressed. 13. Ovipositor about 2.5 as long as hind femur, straight. *Color:* Head and mesosoma black, the following whitish yellow: mandible except for brown of base and apex, palpi, scape and pedicel ventrally, tegula, fore and middle coxae except for dark brown of extreme base, apex of hind coxa, trochanters, and dorsal basal spot of hind tibia. Fore and middle legs otherwise brownish red. Hind leg with femur brownish red except for brown of apical 0.2; tibia and tarsi brown except for brownish yellow median 0.4 of tibia. FMS fuscous except for brownish red apical 0.3 of postpetiole. Apical 0.2 of T2, whitish yellow; ventral 0.5 of lateral areas of T4-6, brownish red; remainder of metasoma dark brown-fuscous. *Length:* 4.3 mm; wing 2.3 mm; ovipositor 2.0 mm.

TYPE MATERIAL. Female holotype [CASC, type no. 15692], *MEXICO—Nayarit:* Acaponeta, 4 May 1953, R.C. Bechtel.

ETYMOLOGY. From the Latin *pumilus,* dwarfish or diminutive, in reference to the very small size.

Venturia punctata, new species
(figs. 3q, 13x, 16j, 21o, 24i, 28i)

DIAGNOSIS. Readily distinguished by the densely punctate or rugosopunctate pronotal upper corner, wide (0.5) gena, elongate mesosoma (fig. 24i), fuscous fore and middle coxae, brown first hind trochanter, brownish red hind femur, loss of most propodeal carinae, uniformly punctate propodeal surface, and brownish red T4-7.

FEMALE. *Structure:* 1. Malar space about 0.5 as long as basal mandibular width. 2. Antenna with 50 flagellomeres. 3. Frontal outline of head similar to fig. 20o, dorsal outline as in fig. 21o. OOD about 1.0. 5. Genal width about 0.5. 5. Mesosomal profile as in fig. 24i; mesonotal profile strongly produced; subalar ridge punctate. 6. Pronotum with epomia absent; lateral area with rugae weak or absent except for strong rugae in lower corner, centrally smooth with scattered punctures; upper corner densely punctate or rugosopunctate, punctures separated by 0.3-0.5 their diameter. 7. Mesopleurum with punctures in central region immediately below hypoepimeron about 0.1 OD, separated by 0.3-0.5 their diameter on moderately granulate surface; scrobal groove with weak rugae from subalar ridge halfway to scrobe; scrobe present only as depressed area, not distinct pit; hypoepimeron with close punctures on dorsal and posterior margins. 8. Propodeum with carinae weak, only basal transverse, pleural, and parts of apical transverse carinae present (fig. 16j); surface covered with punctures on weakly granulate surface, punctures separated by about 0.5 their diameter to contiguous; propodeal neck about 0.5 as long as wide. 9. Hind femur about 5.5 as long as wide; hind tibial spur about 0.5 as long as hind basitarsus. 10. Areolet petiolate, stalk about 0.2 as long as cell (fig. 3q). 11. FMS with petiole about 1.7 as long as postpetiole and with two faint dorsolateral grooves, postpetiole depressed (fig. 13x). 12. T2 about 1.9 as long as apical width; metasoma moderately compressed. 13. Ovipositor about 2.6 as long as hind femur, straight except for weakly upcurved tip. *Color:* Head and mesosoma black, the following whitish yellow: mandible except for brown of base and apex, and tegula. Palpi brownish yellow. Coxae dark brown-fuscous, except for brownish yellow of extreme apices. Trochanters brownish yellow, except for dark brown first hind trochanter, and irregular brownish areas of second hind trochanter. Fore and middle legs otherwise light brownish red. Hind femur brownish red, base and apex brownish; hind tibia and tarsi dark brown, median 0.5 of tibia lighter. FMS with petiole black, postpetiole piceous. T2 except for apical 0.1, and basal 0.3 of T3, fuscous; metasoma otherwise brownish red. *Length:* 8.4 mm (8.6 mm); wing 5.2 mm (5.3 mm); ovipositor 3.6 mm (3.7 mm).

MALE. *Structure:* Similar to female, antennae incomplete but with minimum of 44 flagellomeres; S9 as in fig. 28i (gonoforceps absent). *Color:* Similar to female except T2 completely fuscous; basal 0.5 of T5 brown, T6-7 fuscous (these possibly due to postmortem changes). *Length:* 8.4 mm; wing 5.8 mm.

TYPE MATERIAL. Female holotype [CASC, type no. 15703], *MEXICO—Zacatecas:* Laguna Balderama, 25 mi. W. Fresnillo, 7900 ft., 23 June 1954, R.H. Brewer. Paratypes, 1F and 1M [CASC], same data as for holotype.

ETYMOLOGY. From the Latin *puncta,* puncture, in reference to the punctate propodeal surface.

Venturia scitula, new species
(figs. 1d, 11, 13p, 16d, 20u-v, 23g, 27a-d)

DIAGNOSIS. This species can be distinguished from others in the Hadra Group by the mesopleural punctures being separated by 0.3-0.5 their diameter on a smooth surface, sharply basally produced and somewhat elongate areola, smooth areolar surface with transverse rugae, fuscous-dark brown coloration of the hind leg, and the fuscous metasoma.

FEMALE. *Structure:* 1. Malar space about 0.5 as long as basal mandibular width. 2. Antenna with 34-37 flagellomeres. 3. Frontal and dorsal outlines of head as in fig. 20u-v; OOD about 0.7. 4. Genal width about 0.4. 5. Mesosomal profile as in fig. 23g; mesonotal profile somewhat produced; subalar ridge punctate. 6. Pronotum with strong epomia; lateral area with strong rugae, surface granulate; upper corner with punctures separated by 0.3-0.5 their diameter on smooth surface. 7. Mesopleurum with punctures in central region immediately below hypoepimeron about 0.1 OD, separated by 0.3-0.5 their diameter on smooth (or occas. weakly granulate) surface; scrobal groove with rugae extending halfway to scrobe, absent adjacent to subalar ridge; hypoepimeron with close punctures on dorsal and posterior margins. 8. Propodeum with areola somewhat elongate and distant from basal propodeal margin, areola-petiolar area juncture weakly constricted (fig. 16d); areola with weak rugulae on smooth surface, petiolar area with fine transverse rugae on smooth surface with coarse punctures; first lateral area with regular punctation on weakly granulate surface, second lateral area with confluent punctures on smooth surface; propodeal neck broad, about 0.3 as long as wide. 9. Hind femur about 5.4 as long as wide; hind tibial spur about 0.5 as long as hind basitarsus. 10. Areolet petiolate, stalk about 0.3 as long as cell. 11. FMS with petiole about 1.6 as long as postpetiole (fig. 13p). 12. T2 about 1.5 as long as apical width; metasoma weakly compressed. 13. Ovipositor 2.7-3.1 as long as hind femur, almost straight. *Color:* Head and mesosoma black,

the following whitish yellow: mandible except for dark brown of base and apex, palpi, tegula, and dorsal surface of fore tibia. Scape ventrally brownish yellow. Fore and middle legs brownish red except for dark brown of basal 0.8 of coxae, and ventral and posterior faces of trochanters. Hind leg with coxae fuscous, trochanters dark brown; femur except for base and apex, and median 0.5 of tibia, deep brownish red; remainder of leg brown. Metasoma fuscous, T3-8 with apices and highlights on lateral areas deep brownish red. *Length:* 6.8-10.8 mm (8.8 mm); wing 4.2-6.3 mm (5.5 mm); ovipositor 3.7-5.7 mm (4.6 mm).

MALE. *Structure:* Similar to female, except antenna with 35-37 flagellomeres; gena more flattened; propodeum with central area narrower and carinae higher and stronger; postpetiole depressed; right gonoforceps and S9 as in figs. 27a-d. *Color:* As in female. *Length:* 7.2-10 mm; wing 4.4-5.5 mm.

TYPE MATERIAL. Female holotype [HMTC], *UNITED STATES—California:* Mariposa Co, Yosemite Nat. Park, Crane Flat, 25 July 1948, H., M., G., D. and J. Townes. Paratypes, *CANADA—Manitoba:* 1F [CNCI], Morris, 20 Aug. 1924, A.V. Michener; 1F [CNCI], Treesbank (?), 11 Aug. 1924, R.D. Bird; *UNITED STATES—California:* 2FF and 15MM [HMTC], 1F and 3MM [DBWC], same data as for holotype; 1F [HMTC], Nevada Co., Sagehen Creek, 10 July 1974, R.M. Bohart; *Florida:* 1F [USNM], Nassau Co., Fernadina, 16 March; *Idaho:* 1F [USNM], Custer Co., nr. Stanley, 8 Aug. 1978, H. & M. Townes; *Kansas:* 1F [USNM], Riley Co., Sept., "158", F. Marlatt; *Massachusetts:* 1F [MCZC], Duke Co., Martha's Vineyard, 26 June 1930, C.W. Johnson; *Michigan:* 1F [HMTC], Gladwin Co., 29 May 1939, R.R. Dreisbach; 1F [HMTC], Lake Co., 10 Aug. 1941, R.R. Dreisbach; 1M [HMTC], Newaygo Co., 31 July 1943, R.R. Dreisbach; 1F [MSUC], Tuscola Co., 20 July 1944, R.R. Dreisbach; *North Carolina:* 1F [UCDC], Currituck Co., Moyock, 8 May 1953, G.H. Nelson; *Ohio:* 1F [HMTC], Jackson Co., 5 Sept. 1941, J.E. Gillaspy; *Oregon:* 1F [USNM], Coos Co., Coos Bay, 19 June 1926, H.A. Scullen; 1F [HMTC], Crook Co., Ochoco Creek, 11 July 1978, H. & M. Townes; 1F [HMTC], Hood River Co., Mt. Hood, 5400 ft., 24 July 1978, H. & M. Townes; 1F and 1M [HMTC], 1F [DBWC], Hood River Co., Parkdale, 18 July 1978 and 20 July 1978, H. & M. Townes; *South Dakota:* 1M [USNM], Orman Dam [?], 19 July 1924.

OTHER SPECIMENS. *UNITED STATES—Arizona:* 1F and 12MM [HMTC], Gila Co., nr. Roosevelt Lake, 21 April 1947, 22 April 1947, 23 April 1947, H. & M. Townes.

FIGURE 11. Localities of *Venturia scitula* Wahl.

COMMENT. In specimens from the western United States, the pronotal rugae tend to be either weak or absent from the median area which is then smooth or weakly granulate. The series of specimens from Arizona is provisionally included in this species, although they differ in the following: 1) females have the gena narrower (0.3), 2) females have the central area narrower and the carinae weaker, 3) males have the central area wider and the propodeal carinae weaker, and 4) the setae on the gonoforceps and S9 are sparser (compare figs. 27c-d, from an Arizona specimen, to figs. 27a-b, from a specimen from California). Figure 11 shows the distribution of this species.

ETYMOLOGY. From the Latin *scitulus,* handsome or elegant, in reference to the polished and strongly punctate mesosoma.

Venturia sculleni, new species
(figs. 13w, 17c, 20w-x, 23k, 27e-f)

DIAGNOSIS. Distinguishable by the rugosopunctate pronotal upper corner, yellow fore and middle coxae, yellow trochanters, lack of a distinct scrobe, lack of transverse rugae on the mesopleural suture, weak carinae of the apical 0.5 of the propodeum, light brownish red hind leg, depressed postpetiole, and brownish red T4-7.

FEMALE. *Structure:* 1. Malar space about 0.4 as long as basal mandibular width. 2. Antenna with 30-32 flagellomeres. 3. Frontal and dorsal outlines of head as in fig. 20w-x; OOD about 0.7. 4. Genal width about 0.3. 5. Mesosomal profile as in fig. 23k; mesonotal profile strongly produced; subalar ridge weakly rugospunctate. 6. Pronotum with strong epomia; lateral area with strong rugae on smooth surface; upper corner with punctures separated by 0.3-0.5 their diameter. 7. Mesopleurum with punctures in central region immediately below hypoepimeron about 0.1 OD, separated by 0.3-0.5 their diameter, on moderately granulate surface; scrobal groove with weak and irregular rugae, extending from subalar ridge halfway to scrobe; hypoepimeron with close, well-defined punctures on dorsal and posterior margins. 8. Propodeum with areola elongate, juncture of areola-petiolar area strongly constricted (fig. 17c); carinae other than basal transverse carina weak or obsolescent; areolar surface strongly granulate, petiolar area finely reticulate on granulate surface; first lateral area with scattered punctures on granulate surface, second lateral area rugosopunctate on granulate surface; propodeal neck about 0.5 as long as wide. 9. Hind femur about 5.9 as long as wide; hind tibial spur about 0.5 as long as hind basitarsus. 10. Areolet petiolate, stalk about 0.3 as long as cell. 11. FMS with petiole about 1.7 as long as postpetiole, postpetiole depressed (fig. 13w). 12. T2 about 1.7 as long as apical width; metasoma moderately compressed. 13. Ovipositor 2.6-3.0 as long as hind femur, moderately curved. *Color:* Head and mesosoma black, the following whitish yellow: mandible except for brown of base and apex, palpi, ventral surfaces of scape and pedicel, tegula, fore and middle coxae except for extreme bases, extreme apex of hind coxa, trochanters, dorsal surface of front tibia, and dorsal spot on base of hind tibia. Coxae otherwise brown to fuscous. Remainder of fore and middle legs brownish red. Remainder of hind leg brownish red, except for dark brown of base and apex of tibia, and tarsus. Petiole with basal 0.8 to entirety, and basal 0.5 of T2, fuscous; remainder of metasoma brownish red. *Length:* 6.5-7.2 mm (6.5 mm); wing 3.6-4.3 mm (3.7 mm); ovipositor 3.1-3.7 mm (3.2 mm).

MALE. *Structure:* Similar to female, except genal width about 0.4; propodeal carinae somewhat stronger than in female; right gonoforceps and S9 as in figs. 27e-f. *Color:* Similar to female, available specimens showing either: a) basal 0.8 of T2, T3, T5-6 except for median transverse bands, T7 and gonoforceps, dark brown to fuscous; b) similar to above but basal dark bands on T5-6 reduced, and T7 with only midline dark brown. *Length:* 5.9 mm; wing 3.4-3.6 mm.

TYPE MATERIAL. Female holotype [HMTC], *UNITED STATES—Arizona:* Cochise Co., 23 mi. NE Douglas, 31 July 1946, H.A. Scullen. Paratypes, *MEXICO—Chihuahua:* 1F [SEMC], Naica, 21 July 1938, L.J. Lipovsky; *UNITED STATES—Arizona:* 1F [USNM], Pima Co., Continental, 2-4 Aug. 1959, K.V. Krombein; *New Mexico:* 1F [LACM], Dona Ana Co., Pyramid Peak, 2 Aug. 1930, "9715", F.R. Fosberg; 1F and 1M [HMTC], 1M [OSUO], 1F [DBWC], Grant Co., 15 mi. E. Lordsburg, 4500 ft., 31 July 1946 and 1 Aug. 1943, H.A. Scullen.

COMMENT. One female has the rugae of the lateral area of the propodeum reduced or obsolescent, as in males.

ETYMOLOGY. This species is named for the late H.A. Scullen, the collector of the type specimen.

Venturia sokanakiakorum (Viereck)
(figs. 1f, 2a, 3a, 12, 13v, 18c, 21u, 24l, 28g-h)

Casinaria (Idechthis) sokanakiakorum Viereck, 1917

(1916). Connecticut State Geol. Nat. Hist. Survey Bull. 22: 270. Male (USNM).

DIAGNOSIS. This species can be distinguished from others in the Nigriscapus Group by the interception of the postnervulus at the midlength, nervulus opposite the basal vein, punctate metapleurum, elongate and narrow areola, and moderately compressed metasoma.

FEMALE. *Structure:* 1. Malar space about 0.4 as long as basal mandibular width. 2. Antenna with 35-38 flagellomeres. 3. Frontal outline of head similar to fig. 20k, dorsal outline as in fig. 21u; OOD about 1.0. 4. Genal width about 0.4. 5. Mesosomal profile as in fig. 24l; mesonotal profile not produced; subalar ridge weakly rugosopunctate. 6. Pronotum with strong epomia; lateral area with rugae strong and extending to lower corner, on smooth surface; upper corner rugosopunctate, punctures separated by about 0.3 their diameter. 7. Mesopleurum with punctures in central region immediately below hypoepimeron about 0.1 OD, separated by 0.3-0.5 their diameter, on moderately granulate surface; scrobal groove with strong rugae extending from subalar ridge to scrobe; hypoepimeron with close punctures on dorsal and upper 0.5 of posterior margins. 8. Propodeum with areola elongate and narrow, juncture of areola-petiolar areas moderately constricted (fig. 18c); areola with transverse rugae on smooth surface, petiolar area reticulate; first lateral area with shallow punctures on granulate surface, second lateral area rugosopunctate; propodeal neck about 0.7 as long as wide. 9. Hind femur about 5.0 as long as wide; hind tibial spur about 0.5 as long as hind basitarsus. 10. Areolet petiolate, stalk about 0.6 as long as cell. 11. FMS with petiole about 1.8 as long as postpetiole, postpetiole high (fig. 13v). 12. T2 about 2.2 as long as apical width; metasoma moderately compressed. 13. Ovipositor 1.3-1.4 as long as hind femur, straight. *Color:* Head and mesosoma black, the following whitish yellow: mandible except for dark brown of base and apex, ventral surface of scape and pedicel, palpi, tegula, fore and middle coxae except for dark brown of extreme base, trochanters, dorsal surfaces of fore and middle tibiae, and extreme base of hind tibia. Remainder of legs brownish red except for dark brown of extreme apex of hind femur, sub-basal and apical bands of hind tibia, and hind tarsi. FMS black except for light brownish red of apical 0.3-0.5 of postpetiole. T2 except for apical 0.3, basal 0.4 of T3, fuscous; remainder of metasoma brownish red. *Length:* 6.0-8.7 mm; wing 3.5-4.8 mm; ovipositor 1.8-2.4 mm.

MALE. *Structure:* Similar to female, except antenna with 36-39 flagellomeres; genal width about 0.5; rugae of scrobal groove usually weak or absent near scrobe; areolet stalk about 0.4 as long as cell; propodeum with central area slightly narrower, carinae stronger and higher; right gonoforceps and S9 as in figs. 28g-h. *Color:* Similar to female, fore and middle coxae pale yellow except for dark brown of extreme base of fore coxa and basal 0.3-0.5 of middle coxa; hind femur with base and apex dark brown; FMS black except for extreme apex of postpetiole; T2 except for brownish white of apical 0.2, basal 0.5 and midline of T3, midlines and upper lateral areas of T5-6, T7, and gonoforceps, fuscous; remainder of metasoma brownish red. *Length:* 7.0-8.0 mm; wing 3.7-4.9 mm.

SPECIMENS EXAMINED. 131 females, 243 males.

TYPE MATERIAL. Male holotype [USNM, CAES no. 127], *UNITED STATES—Connecticut:* New Haven Co., New Haven, 4 July 1905, H.L. Viereck.

DISTRIBUTION. Fig. 12; found throughout eastern Canada and the eastern United States to about 100° W. Isolated localities are in Saskatchewan (Waskesin Lake) and Idaho (Collins). One specimen was collected in Mexico (*Nayarit:* Arroyo Refelion, nr. Compostela, 8 Aug. 1965, H.E. Evans); Carlson (1979) states that he has examined a specimen of this species from Guatemala.

COMMENT. Several color forms are seen in this species. Male specimens from Canada and from some localities in Michigan, New York, and Ohio can have the mandible, apical 0.5 of the fore coxa, most or all of the second coxa, and the hind tibia, dark brown to fuscous. Females, while exhibiting infuscation of the coxae, generally do not show the other color states. Females from the Gulf Lake Biological Station, Kalamazoo, Michigan, exhibit the extremes of color. Specimens from McAllen, Texas, differ in that the females have the midlines of T3-7 fuscous. In addition, males can have T4-7 almost completely dark brown or fuscous except for narrow brownish red apices.

Most dates of collection are from late May to mid-September. Specimens from McAllen, Texas, have been collected from September through May.

Venturia spectabilis, new species (figs. 13n, 15f, 19e-f, 22b)

DIAGNOSIS. Distinguished from other small species with roundish heads, parallel inner ventral margins of the compound eyes, and

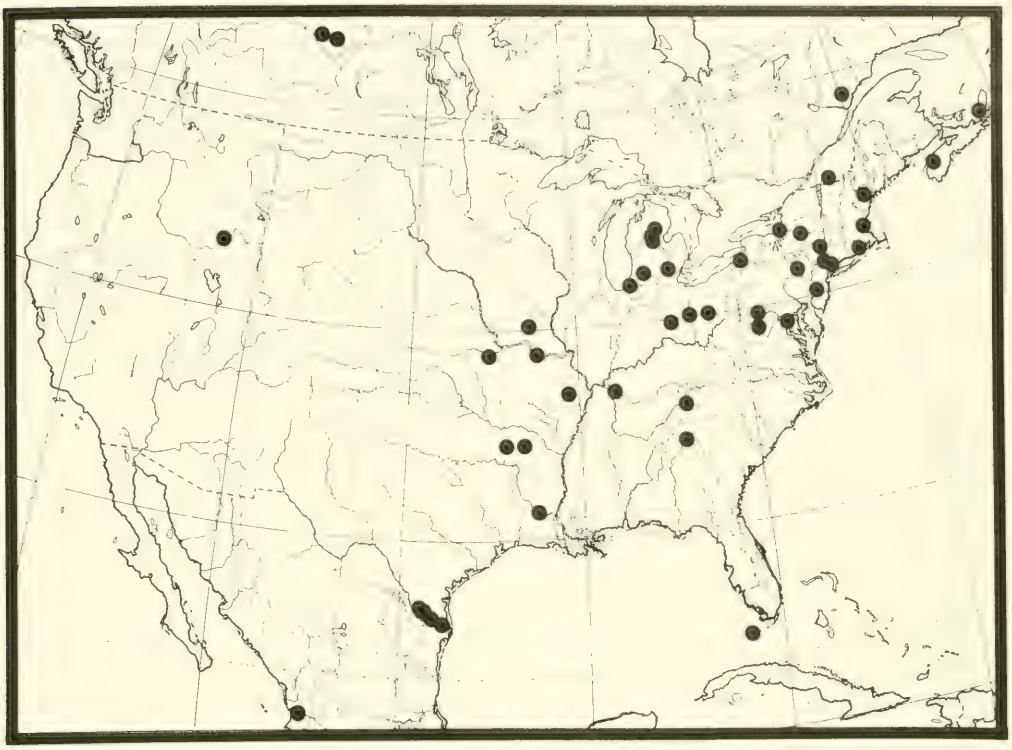

FIGURE 12. Localities of *Venturia sokanakiakorum* (Vier.).

sparsely punctate pronotal upper corners by the somewhat elongate areola adjacent to the basal propodeal margin, dark brown hind femur, fuscous coxae and metasoma, and long (3.6-3.7 as long as the hind femur) and straight ovipositor.

FEMALE. *Structure:* 1. Malar space about 0.4 as long as basal mandibular width. 2. Antenna with 28 flagellomeres. 3. Frontal and dorsal outlines of head as in fig. 19e-f; OOD about 0.9. 4. Genal width about 0.4. 5. Mesosomal profile as in fig. 22b; mesonotal profile strongly produced; subalar ridge weakly rugosopunctate. 6. Pronotum with epomia weak; lateral area with weak rugae, on smooth surface; upper corner with sparse punctures on strongly granulate surface. 7. Mesopleurum with punctures in central region immediately below hypoepimeron about 0.1 OD, separated by about their diameter, on strongly granulate surface; hypoepimeral groove with strong rugae from subalar ridge to near scrobe; hypoepimeron with punctures absent on dorsal and posterior margins. 8. Propodeum with areola somewhat elongate, juncture of areola-petiolar area strongly constricted (fig. 15f); areolar surface strongly granulate, petiolar area with weak transverse rugae on granulate surface; first and second lateral areas with sparse weak punctures on strongly granulate surface; propodeal neck about 0.7 as long as wide. 9. Hind femur about 5.1 as long as wide; hind tibial spur about 0.5 as long as hind basitarsus. 10. Areolet petiolate, stalk about 0.4 as long as cell. 11. FMS with petiole about 1.5 as long as postpetiole (fig. 13n). 12. T2 about 2.0 as long as apical width; metasoma moderately compressed. 13. Ovipositor 3.6-3.7 as long as hind femur, almost straight. *Color:* Head and mesosoma black, the following whitish yellow: mandible except for brown of base and apex, palpi, scape ventrally, extreme apices of coxae, trochanters except for brown first hind trochanter, and dorsal basal spot of hind tibia. Coxae otherwise fuscous. Remainder of fore and middle legs brownish red. Remainder of hind leg dark brown except for lighter median 0.4 of tibia. Metasoma dark brown-fuscous except for brownish red apicolateral corners of T2. *Length:* 4.4-5.0 mm (4.5 mm); wing 3.0-3.1 mm (2.9 mm); ovipositor 3.5-3.6 mm (3.6 mm).

TYPE MATERIAL. Female holotype [MCZC], *UNITED STATES—North Carolina:* Buncombe Co., Black Mountain City, 2700 ft.,

22 Aug. 1930, N. Banks. Paratype, 1F [CEDC], *UNITED STATES—Ohio:* Jefferson Co., 8 Aug. 1967, C. Dasch).

OTHER SPECIMENS. *UNITED STATES—New York:* 1F [FSCA], Westchester Co., Armonk, Calder Center, 12-18 Aug. 1974, "Malaise trap", C. Calmbacher.

ETYMOLOGY. From the Latin *spectabilis,* notable or showy, in reference to the unusually long ovipositor.

Venturia taneces, new species
(figs. 4c, 14e, 16l, 21t, 23j)

DIAGNOSIS. Distinguishable from other species with a completely fuscous metasoma by the rugosopunctate pronotal upper corner, predominately dark brown coxae, fuscous first hind trochanter and hind femur, short areola with the surface granulate, and the nearly straight ovipositor with an elongate and upcurved tip.

FEMALE. *Structure:* 1. Malar space about 0.4 as long as basal mandibular width. 2. Antenna with 31-34 flagellomeres. 3. Frontal outline of head similar to fig. 20o, dorsal outline as in fig. 21t; OOD about 0.7. 4. Genal width about 0.4. 5. Mesosomal profile as in fig. 23j; mesonotal profile strongly produced; subalar ridge weakly rugosopunctate. 6. Pronotum with strong epomia; lateral area with strong rugae except where obsolescent adjacent to front edge, on smooth surface; upper corner rugosopunctate, punctures separated by about 0.3 their diameter. 7. Mesopleurum with punctures in central region immediately below hypoepimeron about 0.1 OD, separated by 1.0-1.5 their diameter, on smooth to weakly granulate surface; scrobal groove with strong rugae from subalar ridge halfway to scrobe; hypoepimeron with close punctures on dorsal and posterior margins. 8. Propodeum with areola about as long as wide, juncture of areola-petiolar area moderately constricted (fig. 16l); areola with weak rugae on granulate surface, petiolar area with strong transverse rugae; first lateral area with regular punctation on granulate surface, second lateral area rugosopunctate on granulate surface; propodeal neck about 0.5 as long as wide. 9. Hind femur about 5.0 as long as wide; hind tibial spur about 0.5 as long as hind basitarsus. 10. Areolet petiolate, stalk about 0.5 as long as cell. 11. FMS with petiole about 1.6 as long as postpetiole (fig. 14e). 12. T2 about 2.1 as long as apical width; metasoma moderately compressed. 13. Ovipositor about 3.0 as long as hind femur, nearly straight except for upcurved tip; apex elongate (fig. 4c). *Color:* Head and mesosoma black, the following whitish yellow: mandible except for brown of base and apex, palpi, tegula, extreme apices of fore and middle coxae, fore and middle trochanters except for brownish tinges on ventral surfaces, dorsal surfaces of fore and middle tibiae, and basal spot on dorsal surface of hind tibia. Fore and middle legs otherwise brownish red, except for irregular brown areas on ventral surface of middle femur and tibia. Coxae (except as noted) and remainder of hind leg, fuscous except for more lightly colored area on median 0.5 of tibia, and brownish yellow coloration of first two tarsomeres. Metasoma black-fuscous, except for deep brownish red apical 0.2 of T2 and apices of T3-7. *Length:* 6.7-8.1 mm (7.3 mm); wing 4.1-4.4 mm (4.4 mm); ovipositor 3.8-4.6 mm (4.2 mm).

TYPE MATERIAL. Female holotype [HMTC], *UNITED STATES—California:* San Diego Co., Julian, 24 May 1974, H. & M. Townes. Paratypes, *UNITED STATES—California:* 1F [DBWC], Los Angeles Co., Newhall, 13 May 1941, R.M. Bohart; 1F [HMTC], Los Angeles Co., Westwood Hills, 25 April 1941, R.M Bohart; 1F [UCDC], San Bernadino Co., Mountain Home, prob. Mountain Home Creek, 15 mi. S. Big Bear Lake near town of Forest Home—*see* Townes & Linna, 1963, 12 Sept. 1953; 2FF [HMTC], 1F [DBWC], San Diego Co., same data as for holotype except collected 25 May 1974 and 27 May 1974; 1F [HMTC], 1F [DBWC], San Diego Co., Lake Wohlford, 26 April 1974 and 30 April 1974, H. & M. Townes.

COMMENT. The metasoma can have the brownish red areas faint or absent; it can also be deep brown with the fuscous coloration of the hind leg accordingly lighter, second hind trochanter brownish yellow, and the dark markings of the middle femur and tibia absent. There is some variation in the degree of the apical curvature of the ovipositor.

ETYMOLOGY. From the Greek *tanekes,* thin or elongate, in reference to the drawn-out apex of the ovipositor.

Venturia texana, new species
(figs. 13i, 17j, 19u-v, 22i)

DIAGNOSIS. Distinguished from other species in the Gelechiae Group by the yellow fore and middle coxae, light brownish red hind femur, elongate areola distant from the basal propodeal margin, fuscous metasoma, and the short (about 2.4 as long as the hind femur) and straight ovipositor.

FEMALE. *Structure:* 1. Malar space about 0.3 as long as basal mandibular width. 2. Antenna with 27 flagellomeres. 3. Frontal and dorsal outlines of head as in fig. 19u-v; eyes ventrally convergent; OOD about 0.9. 4. Genal width about 0.4. 5. Mesosomal profile as in fig. 22i; mesonotal profile strongly produced; subalar ridge weakly rugosopunctate. 6. Large portion of pronotum covered by glue; lateral area with rugae weak or absent in lower corner, on smooth surface; upper corner probably with sparse punctures on strongly granulate surface. 7. Mesopleurum with punctures in central region immediately below hypoepimeron about 0.1 OD, separated by about their diameter, on moderately granulate surface; scrobal groove with strong rugae from subalar ridge halfway to scrobe; hypoepimeron with punctures absent on dorsal and posterior margins. 8. Propodeum with areola elongate, juncture of areola-petiolar area moderately constricted (fig. 17j); areola with few weak rugae on granulate surface, petiolar area with fine transverse rugae on granulate surface; first lateral area with shallow regular punctation on granulate surface, second lateral area weakly rugosopunctate on granulate surface; propodeal neck about 0.5 as long as wide. 9. Hind femur about 5.4 as long as wide; hind tibial spur about 0.5 as long as hind basitarsus. 10. Areolet petiolate, stalk about 0.4 as long as cell. 11. FMS with petiole about 1.5 as long as postpetiole (fig. 13i). 12. T2 about 2.2 as long as apical width; metasoma moderately compressed. 13. Ovipositor about 2.4 as long as hind femur, straight. *Color:* Head and mesosoma black, the following whitish yellow: mandible except for brown of base and apex, palpi, scape and pedicel ventrally, tegula, trochanters except for yellowish brown first hind trochanter, dorsal surfaces of fore and middle tibiae, and dorsal basal spot of hind tibia. Fore and middle legs otherwise light brownish red except for brown of extreme bases of coxae. Hind coxa dark brown except for brownish yellow of apical 0.2. Hind femur brownish red except for brown tinge of apical 0.2; hind tibia and tarsi otherwise brown, except for brownish red of median dorsal 0.3 of tibia. FMS dark brown-fuscous except for brownish red of apex of postpetiole. Apical 0.2 of T2, and apical 0.3 of T6-7, light brownish red; remainder of metasoma dark brown. *Length:* 5.1 mm; wing 2.6 mm; ovipositor 2.3 mm.

TYPE MATERIAL. Female holotype [HMTC], *UNITED STATES—Texas:* Culberson Co., McKittrick Canyon, 17 Aug. 1961, 5200 ft., F. & N. Gehlbach.

ETYMOLOGY. The specific name derives from the state of Texas where the specimens were collected.

Venturia tezcatlipocai Wahl
(fig. 18i)

Venturia tezcatlipocai Wahl, 1984. Contrib. American Entomol. Inst. 22: 26. Female (CASC).

Distinguishable from the other species of the Nigriscapus Group by the reddish yellow ventral surface of the scape, medially arched occipital carina, presence of an apparent hypoepimeral extension, yellow fore and middle coxae, smooth mesopleural surface, shape of the central area of the propodeum (fig. 18i), punctate scutellum and metapleurum, fucous FMS with the apical 0.5 of the postpetiole brownish red, and the fuscous midlines of T4-7.

This species is found in Mexico (San Luis Potosi).

Venturia townesorum Wahl
(fig. 18e)

Venturia townesorum Wahl, 1984. Contrib. American Entomol. Inst. 22: 14. Female (HMTC).

This species can be easily distinguished from the others in the Nigriscapus Group by the brown ventral surface of the scape, medially arched occipital carina, lack of an apparent hypoepimeral extension, fuscous fore and middle coxae, weakly granulate mesopleurum, weak carinae of the apical 0.5 of the propodeum (fig. 18e), coarsely rugosopunctate scutellum and metapleurum, and brownish red apex of the petiole and entire postpetiole. Although Mexican species of *V. nigriscapus* also have the fore and middle coxae fuscous, *townesorum* has the middle femur yellow and the postpetiole brownish red.

This species occurs in Mexico (San Luis Potosí and Veracruz) and Panama.

Venturia tristis, new species
(figs. 14o, 17e, 20e-f, 24c)

DIAGNOSIS. Recognizable by the narrow (0.3) gena, rugosopunctate pronotal upper corner, weakly granulate mesopleurum with punctures separated by 0.3-0.5 their diameter, whitish yellow fore and middle coxae, brownish red hind femur, elongate and narrow areola near the basal propodeal margin, brownish red T4-7, and large size (9.3 mm).

FEMALE. *Structure:* 1. Malar space about 0.5 as long as basal mandibular width. 2. Antenna with 34 flagellomeres. 3. Frontal and dorsal outlines of head as in fig. 20e-f; OOD about 0.9. 4. Genal width about 0.3. 5. Mesosomal profile as in fig. 24c; mesonotal profile somewhat produced; subalar ridge punctate. 6. Pronotum with strong epomia; lateral area with strong rugae except where absent adjacent to front margin, on weakly granulate surface; band of punctation parallel to front margin; upper corner rugosopunctate, punctures separated by about 0.3 their diameter or contiguous. 7. Mesopleurum with punctures in central region immediately below hypoepimeron about 0.1 OD, separated by 0.3-0.5 their diameter, on weakly granulate surface; scrobal groove with strong rugae from subalar ridge to about 0.7 of distance to scrobe; hypoepimeron with close punctures on dorsal and upper 0.5 of posterior margins. 8. Propodeum with areola elongate, juncture of areola-petiolar area weakly constricted (fig. 17e); areola with weak rugae on granulosopunctate surface, petiolar area distinctly concave and with strong transverse rugae; first lateral area with regular punctation on granulate surface, second lateral area rugosopunctate on granulate surface; propodeal neck about 0.6 as long as wide. 9. Hind femur about 6.0 as long as wide; hind tibial spur about 0.5 as long as hind basitarsus. 10. Areolet subpetiolate, stalk about 0.1 as long as cell. 11. FMS with petiole about 1.6 as long as postpetiole (fig. 14o). 12. T2 about 3.0 as long as apical width; metasoma strongly compressed. 13. Ovipositor about 3.1 as long as hind femur, moderately curved. *Color:* Head and mesosoma black, the following whitish yellow: mandible except for brown of base and apex, palpi, scape and pedicel ventrally, tegula, fore and middle coxae except for dark brown of basal 0.3, extreme apex of hind coxa, trochanters, and dorsal basal spot of hind tibia. Fore and middle legs otherwise lght brownish red. Hind femur brownish red; hind tibia and tarsi dark brown. FMS black; T2 and basal 0.3 of T3, fuscous; remainder of metasoma brownish red. *Length:* 9.3 mm; wing 5.1 mm; ovipositor 5.2 mm.

TYPE MATERIAL. Female holotype [USNM], *MEXICO—Nuevo Leon:* "Cadereyta" (presumably Cadereyta Jiménez), 17 April 1947, "Las-44184; 47-9641; on top mammoth cactus."

ETYMOLOGY. From the Latin *tristis,* sad, in reference to the paucity of specimens for this species.

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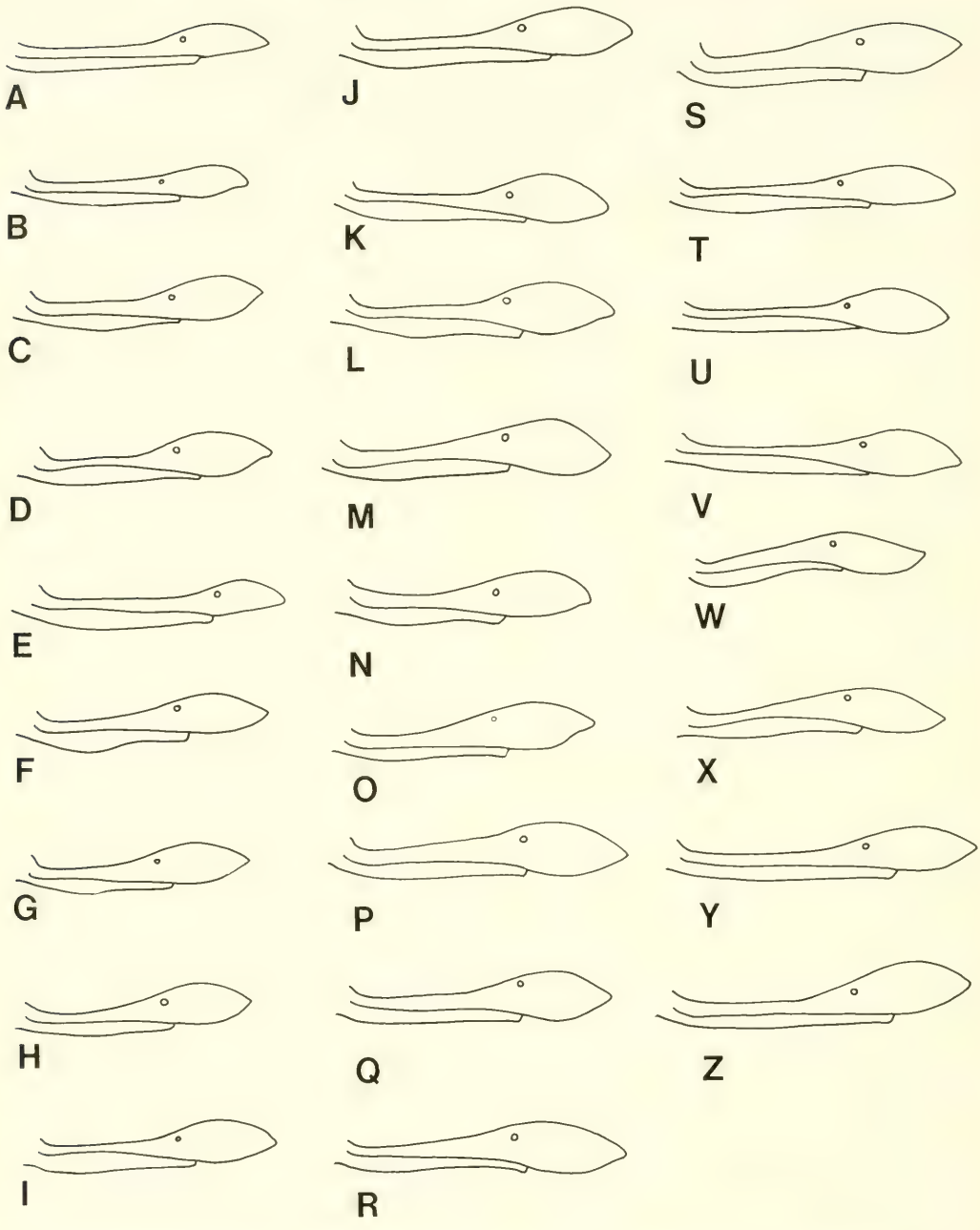

FIGURE 13. Lateral aspect of first metasomal segment. A. *Venturia leptogaster* (Cam.), B. *V. anareolata* Wahl, C. *V. gaesata* Wahl, D. *V. marjoriella* Wahl, E. *V. pumila* Wahl, F. *V. mulleola* Wahl, G. *V. amplareolata* Wahl, H. *V. australis* Wahl, I. *V. texana* Wahl, J. *V. pullata* Wahl, K. *V. chnaura* Wahl, L. *V. eremna* Wahl, M. *V. latrunculus* Wahl, N. *V. spectabilis* Wahl, O. *V. hadra* Wahl, P. *V. scitula* Wahl, Q. *V. brachypropodealis* Wahl, R. *V. erythrogaster* Wahl, S. *V. finlaysonae* Wahl, T. *V. compacta* Wahl, U. *V. anchisteus* Wahl, V. *V. sokanakiakorum* (Vier.), W. *V. sculleni* Wahl, X. *V. punctata* Wahl, Y. *V. daschi* Wahl, Z. *V. fuscifemorata* Wahl.

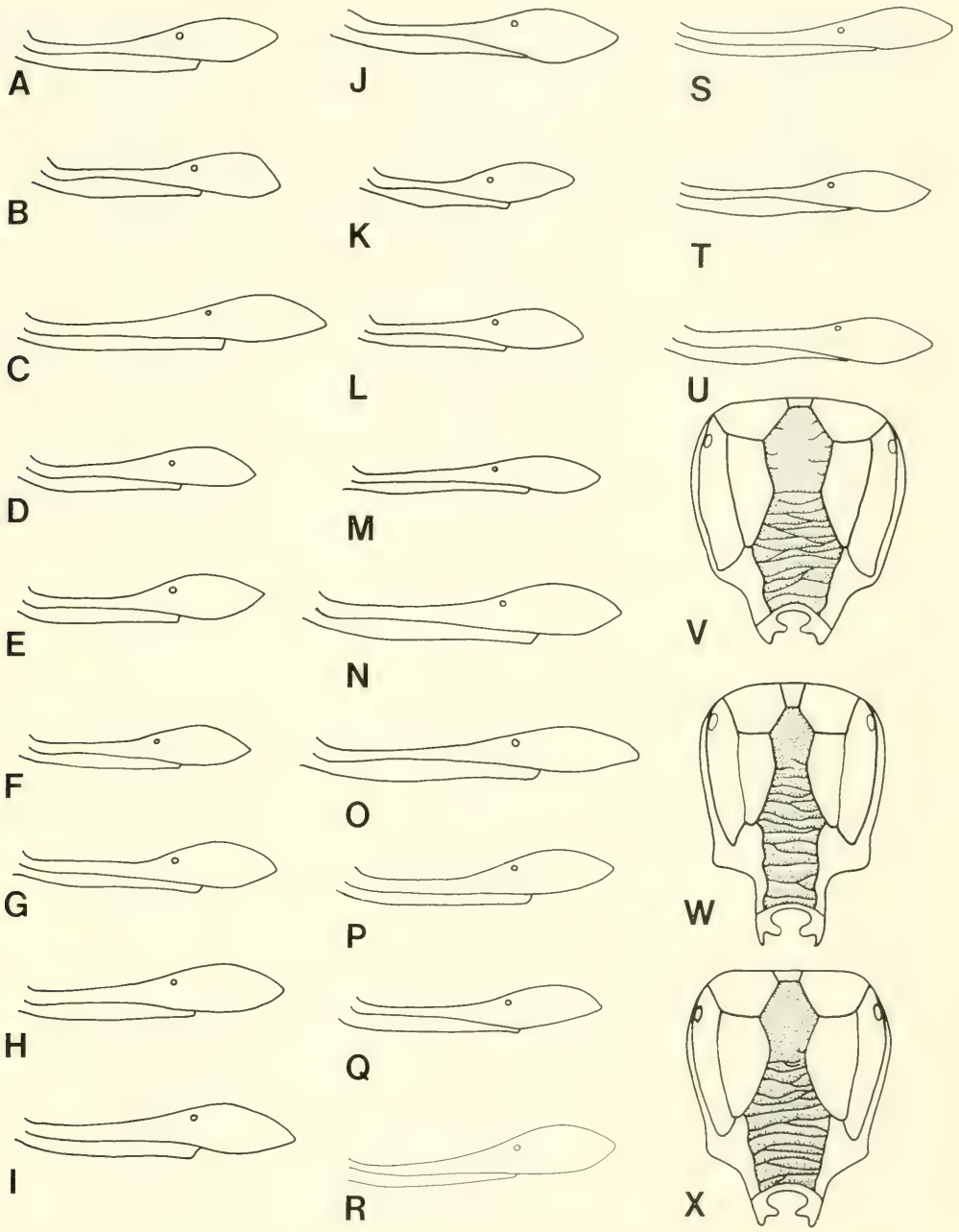

FIGURE 14. **A-U,** Lateral aspect of first metasomal segment. A. *Venturia nigricoxalis* (Cush.), B. *V. longicuspis* Wahl, C. *V. micheneri* Wahl, D. *V. dreisbachi* Wahl, E. *V. taneces* Wahl, F. *V. capulata* Wahl, G. *V. micraulax* Wahl, H. *V. hibiscellae* Wahl, I. *V. platyura* Wahl, J. *V. portalensis* Wahl, K. *V. mayi* Wahl, L. *V. nickelseni* Wahl, M. *V. prolixa* Wahl, N. *V. erythropus* (Ash.), O. *V. tristis* Wahl, P. *V. canescens* (Grav.), Q. *V. gelechiae* (Ash.), R. *V. licina* Wahl, S. *V. floridensis* Wahl, T. *V. masoni* Wahl, U. *V. durangensis* Wahl. **V-X,** Dorsal aspect of propodeum. V. *V. australis* Wahl, W. *V. mayi* Wahl, X. *V. pullata* Wahl.

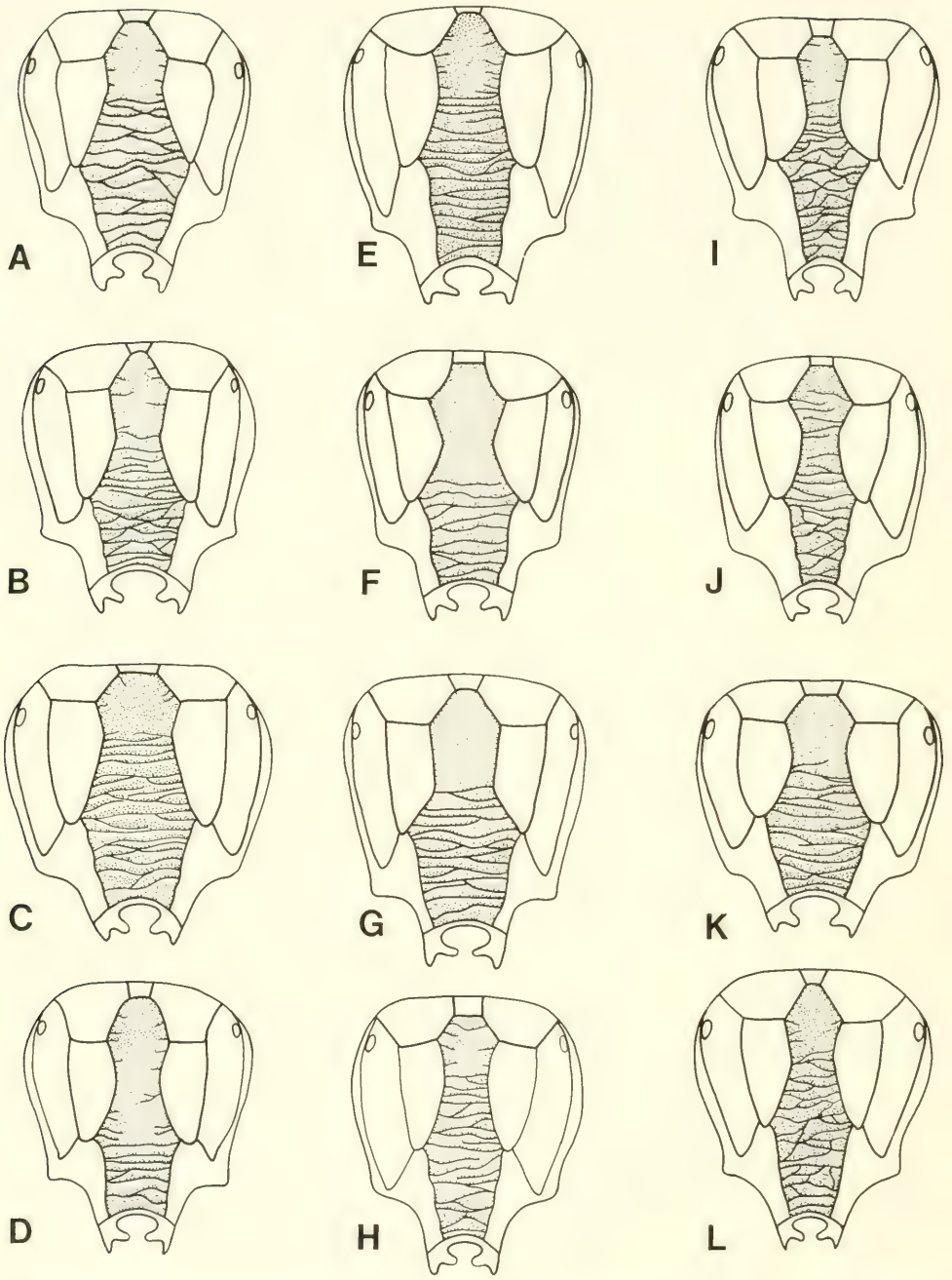

FIGURE 15. Dorsal aspect of propodeum. A. *Venturia eremna* Wahl, B. *V. chnaura* Wahl, C. *V. gaesata* Wahl, D. *V. amplareolata* Wahl, E. *V. gelechiae* (Ash.), F. *V. spectabilis* Wahl, G. *V. marjoriella* Wahl, H. *V. anareolata* Wahl, I. *V. leptogaster* (Cam.), J. *V. pumila* Wahl, K. *V. mulleola* Wahl, L. *V. capulata* Wahl.

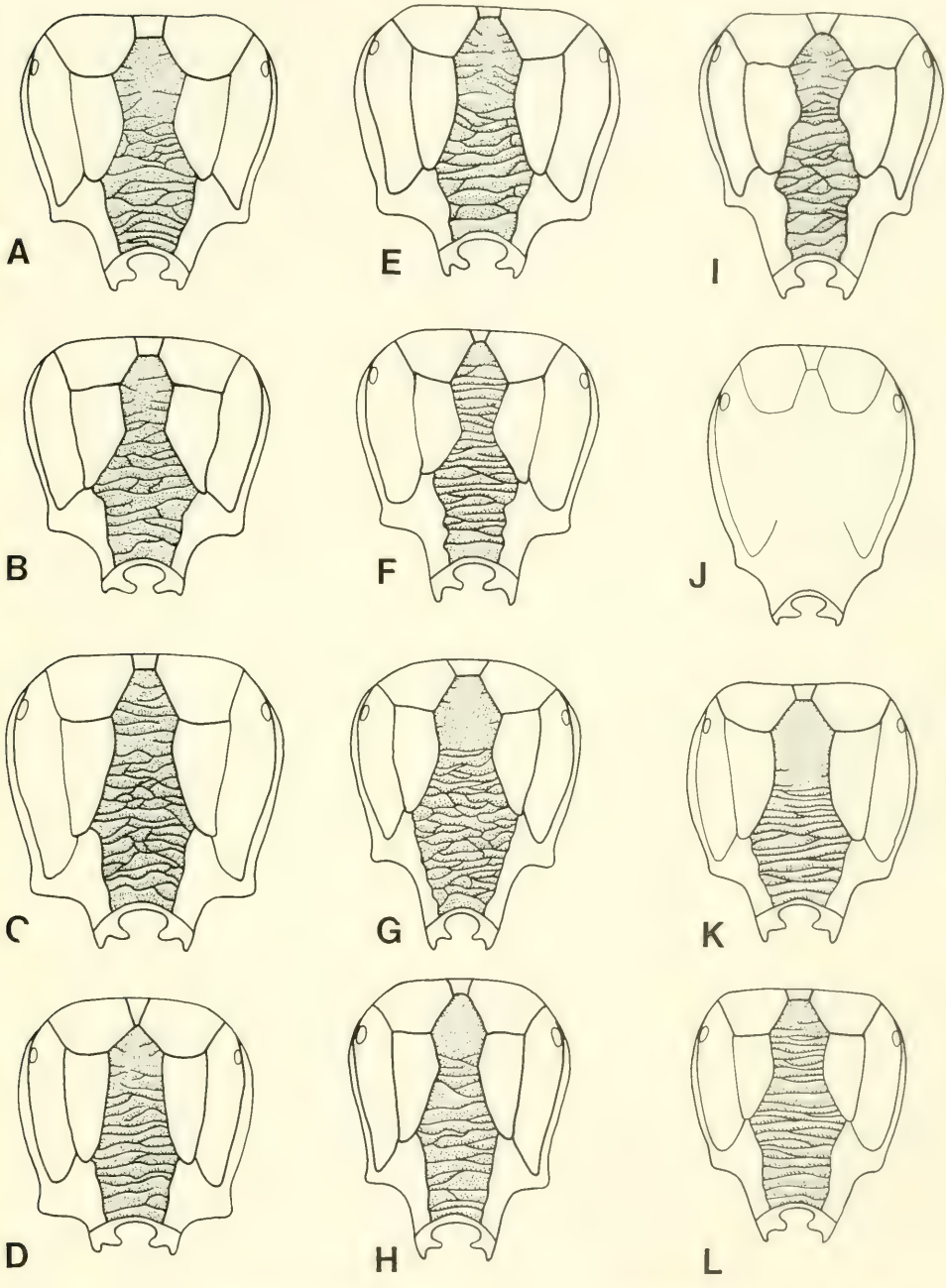

FIGURE 16. Dorsal aspect of propodeum. A. *Venturia finlaysonae* Wahl, B. *V. hadra* Wahl, C. *V. erythrogaster* Wahl, D. *V. scitula* Wahl, E. *V. brachypropodealis* Wahl, F. *V. portalensis* Wahl, G. *V. nickelseni* Wahl, H. *V. dreisbachi* Wahl, I. *V. nigricoxalis* (Cush.), J. *V. punctata* Wahl, K. *V. latrunculus* Wahl, L. *V. taneces* Wahl.

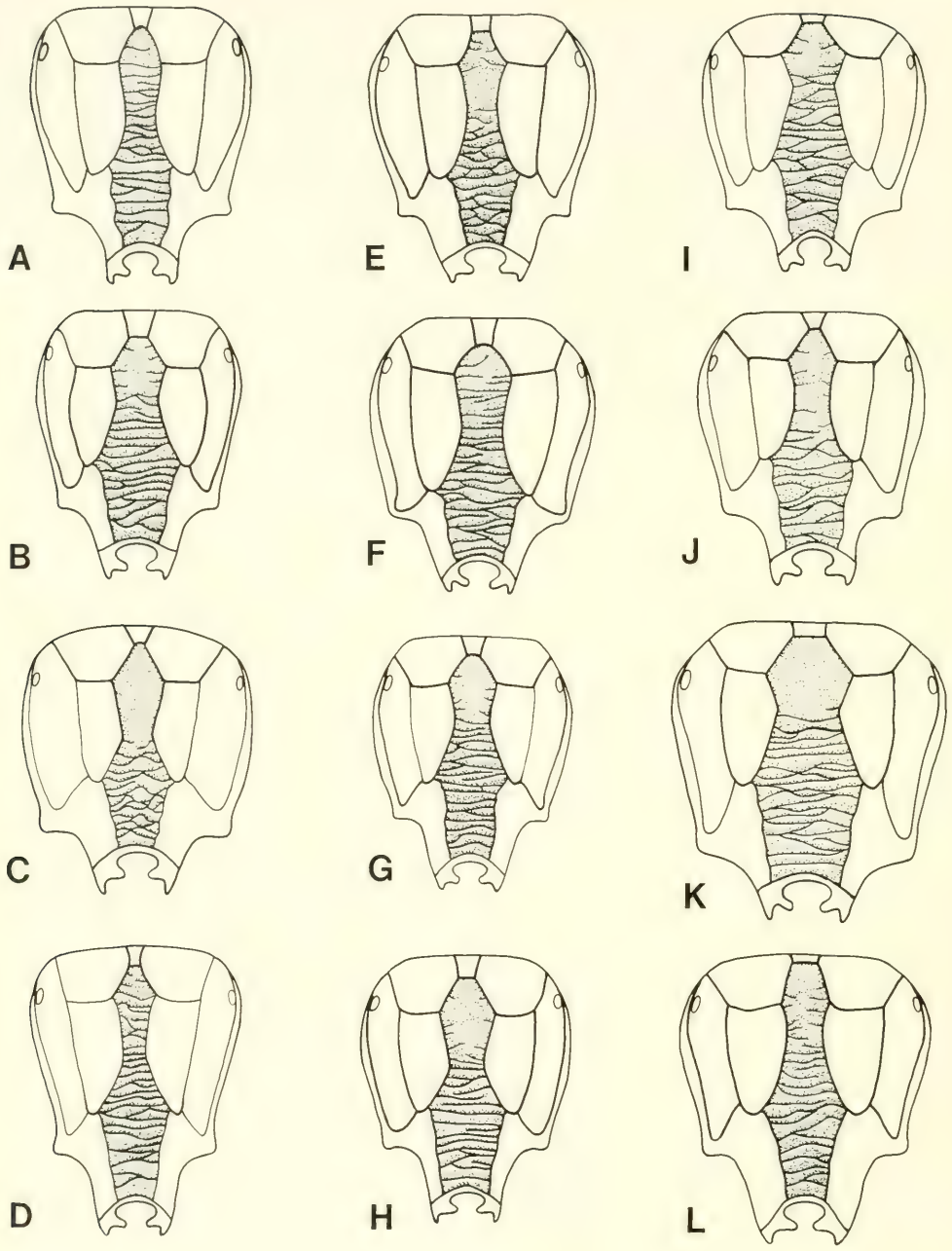

FIGURE 17. Dorsal aspect of propodeum. A. *Venturia canescens* (Grav.), B. *V. hibiscellae* Wahl, C. *V. sculleni* Wahl, D. *V. prolixa* Wahl, E. *V. tristis* Wahl, F. *V. erythropus* (Ash.), G. *V. micheneri* Wahl, H. *V. platyura* Wahl, I. *V. longicuspis* Wahl, J. *V. texana* Wahl, K. *V. micraulax* Wahl, L. *V. fuscifemorata* Wahl.

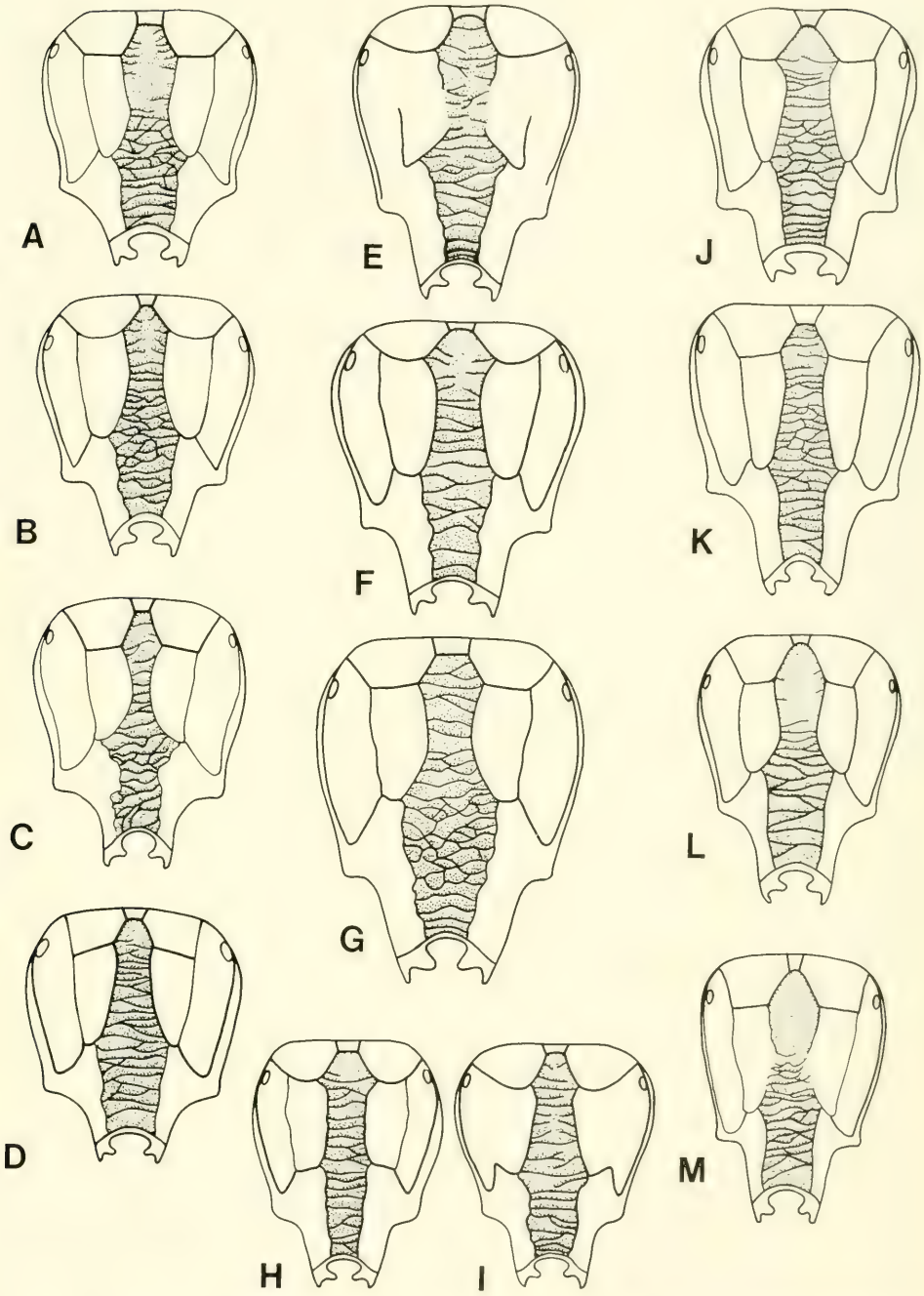

FIGURE 18. Dorsal aspect of propodeum. A. *Venturia daschi* Wahl, B. *V. compacta* Wahl, C. *V. sokanakiakorum* (Vier.), D. *V. anchisteus* Wahl, E. *V. townesorum* Wahl, F. *V. nigriscapus* (Vier.), G. *V. musae* Wahl, H. *V. macilenta* (Cr.), I. *V. tezcatlipocai* Wahl, J. *V. licina* Wahl, K. *V. floridensis* Wahl, L. *V. masoni* Wahl, M. *V. durangensis* Wahl.

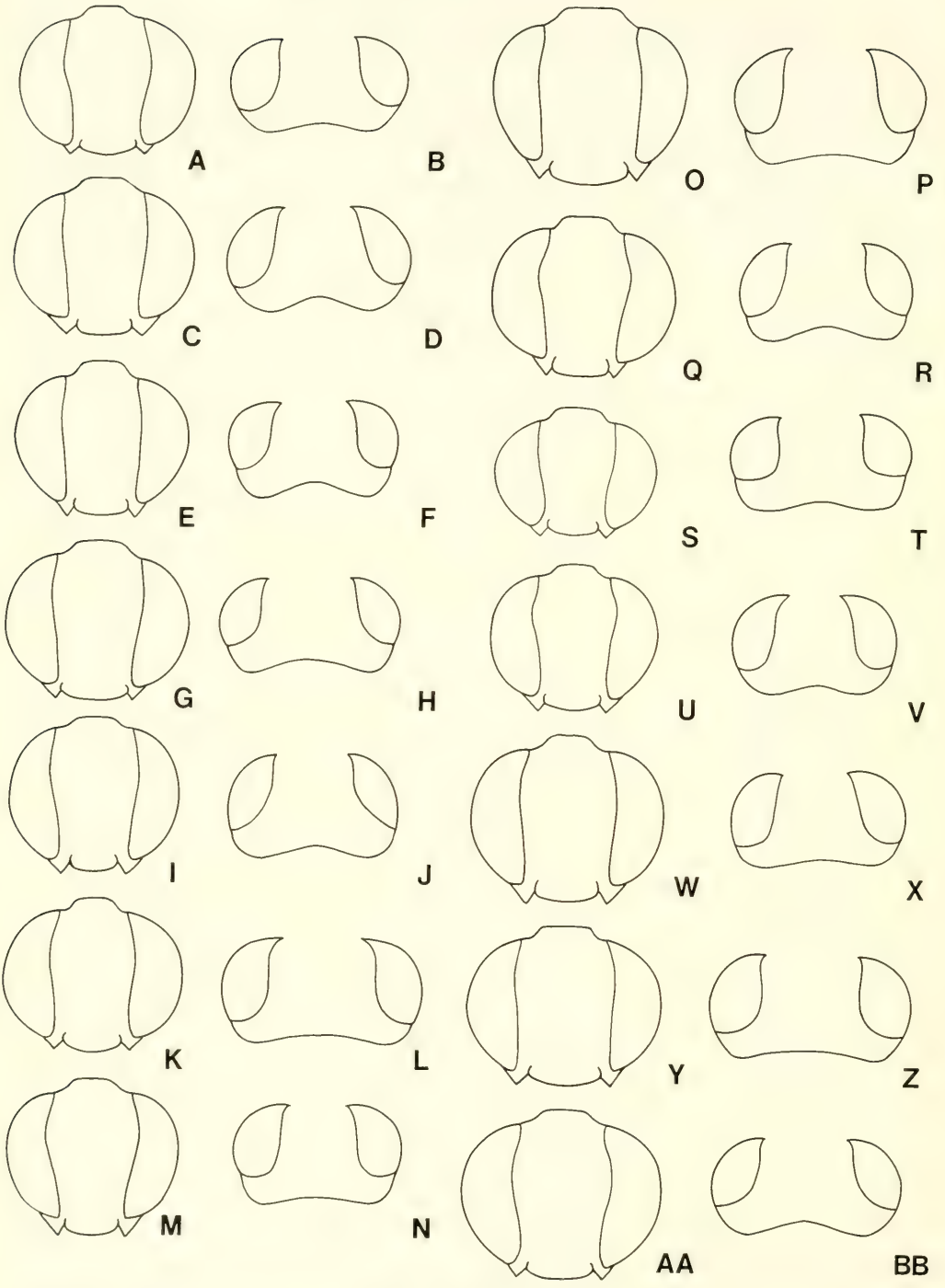

FIGURE 19. Frontal and dorsal aspects of head. A-B. *Venturia chnaura* Wahl, C-D. *V. pumila* Wahl, E-F. *V. spectabilis* Wahl, G-H. *V. pullata* Wahl, I-J. *V. australis* Wahl, K-L. *V. gaesata* Wahl, M-N. *V. mayi* Wahl, O-P. *V. leptogaster* (Cam.), Q-R. *V. anareolata* Wahl, S-T. *V. marjoriella* Wahl, U-V. *V. texana* Wahl, W-X. *V. eremna* Wahl, Y-Z. *V. mulleola* Wahl, AA-BB. *V. gelechiae* (Ash.).

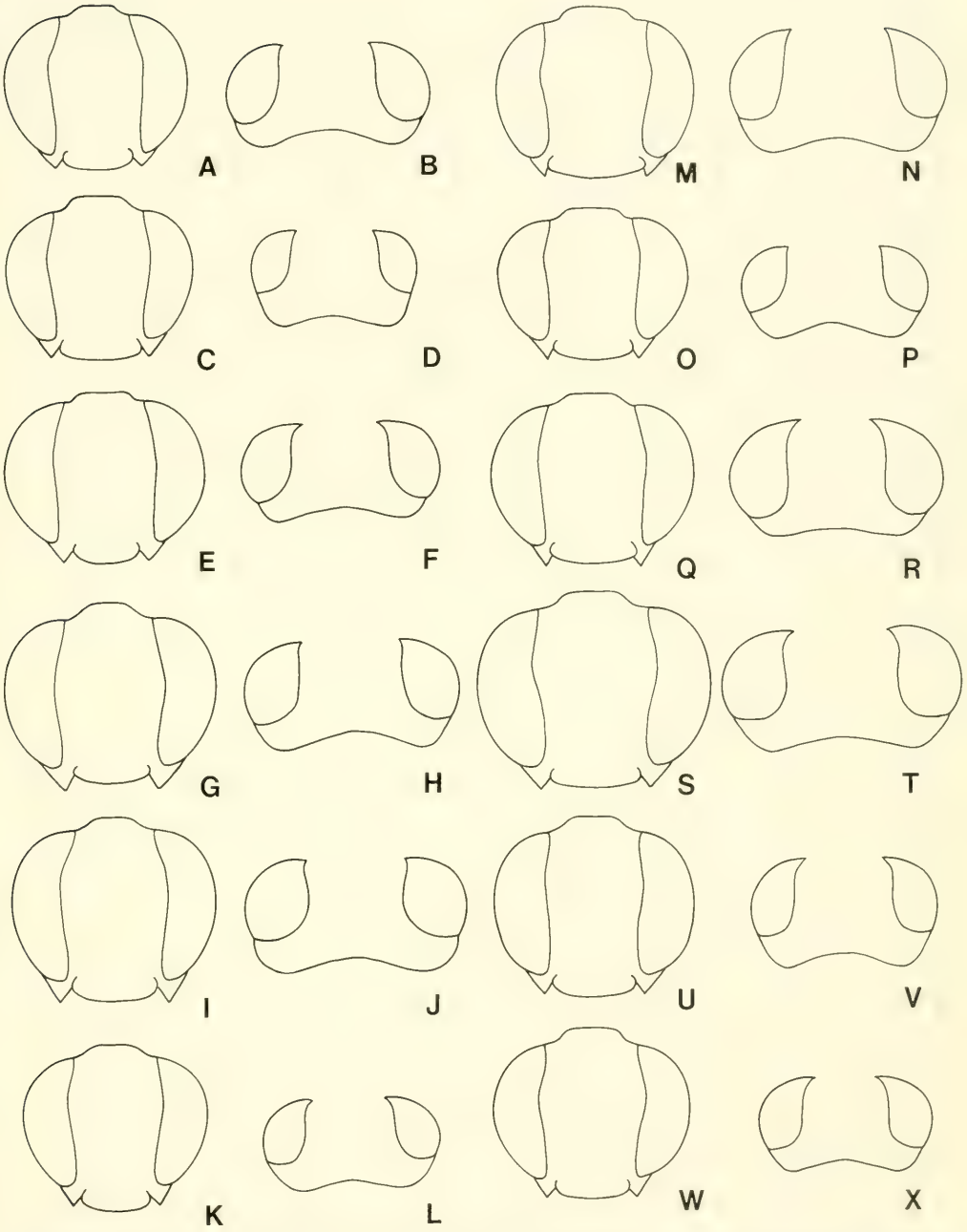

FIGURE 20. Frontal and dorsal aspects of head. A-B. *Venturia amplareolata* Wahl, C-D. *V. latrunculus* Wahl, E-F. *V. tristis* Wahl, G-H. *V. nigricoxalis* (Cush.), I-J. *V. erythropus* (Ash.), K-L. *V. compacta* Wahl, M-N. *V. anchisteus* Wahl, O-P. *V. daschi* Wahl, Q-R. *V. micheneri* Wahl, S-T. *V. fuscifemorata* Wahl, U-V. *V. scitula* Wahl, W-X. *V. sculleni* Wahl.

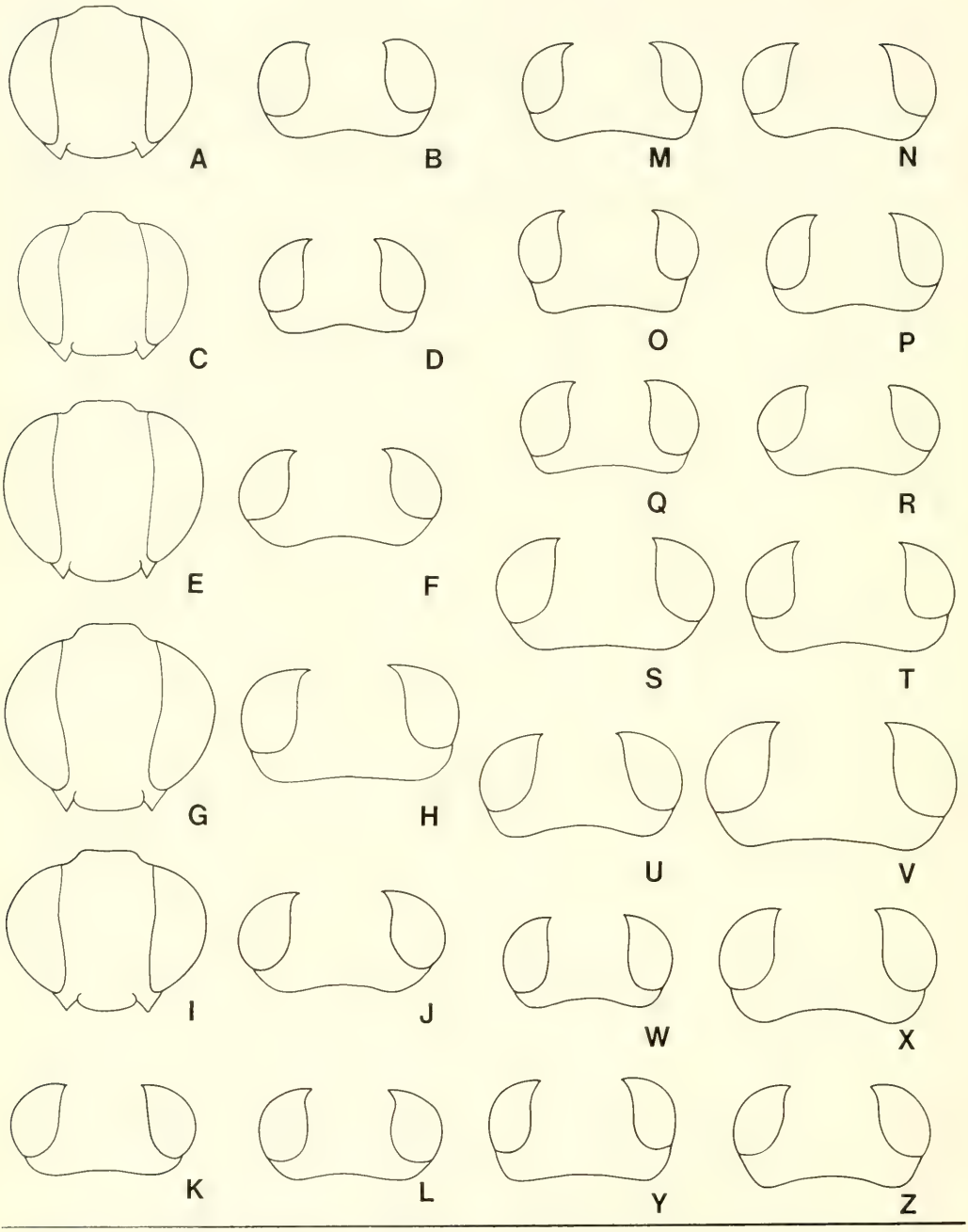

FIGURE 21. **A-J,** Frontal and dorsal aspects of head. A-B. *Venturia capulata* Wahl, C-D. *V. licina* Wahl, E-F. *V. floridensis* Wahl, G-H. *V. masoni* Wahl, I-J. *V. durangensis* Wahl. **K-Z,** Dorsal aspect of head. K. *V. portalensis* Wahl, L. *V. platyura* Wahl, M. *V. dreisbachi* Wahl, N. *V. nickelseni* Wahl, O. *V. punctata* Wahl, P. *V. longicuspis* Wahl, Q. *V. micraulax* Wahl, R. *V. hibiscellae* Wahl, S. *V. prolixa* Wahl, T. *V. taneces* Wahl, U. *V. sokanakiakorum* (Vier.), V. *V. erythrogaster* Wahl, W. *V. canescens* (Grav.), X. *V. hadra* Wahl, Y. *V. brachypropodealis* Wahl, Z. *V. finlaysonae* Wahl.

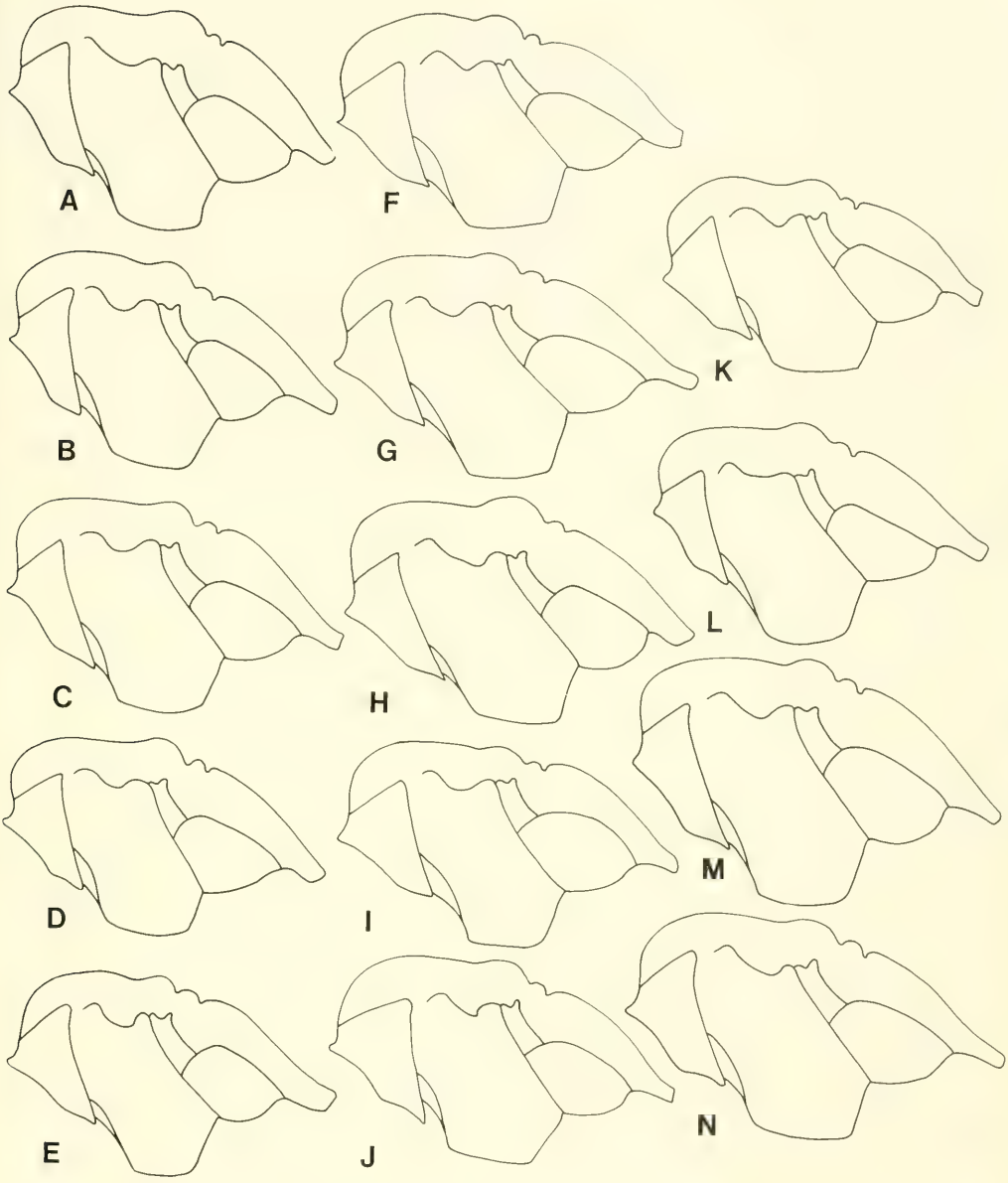

FIGURE 22. Lateral aspect of mesosoma. A. *Venturia mulleola* Wahl, B. *V. spectabilis* Wahl, C. *V. eremna* Wahl, D. *V. marjoriella* Wahl, E. *V. mayi* Wahl, F. *V. amplareolata* Wahl, G. *V. anareolata* Wahl, H. *V. gaesata* Wahl, I. *V. texana* Wahl, J. *V. australis* Wahl, K. *V. chnaura* Wahl, L. *V. pumila* Wahl, M. *V. gelechiae* (Ash.), N. *V. leptogaster* (Cam.).

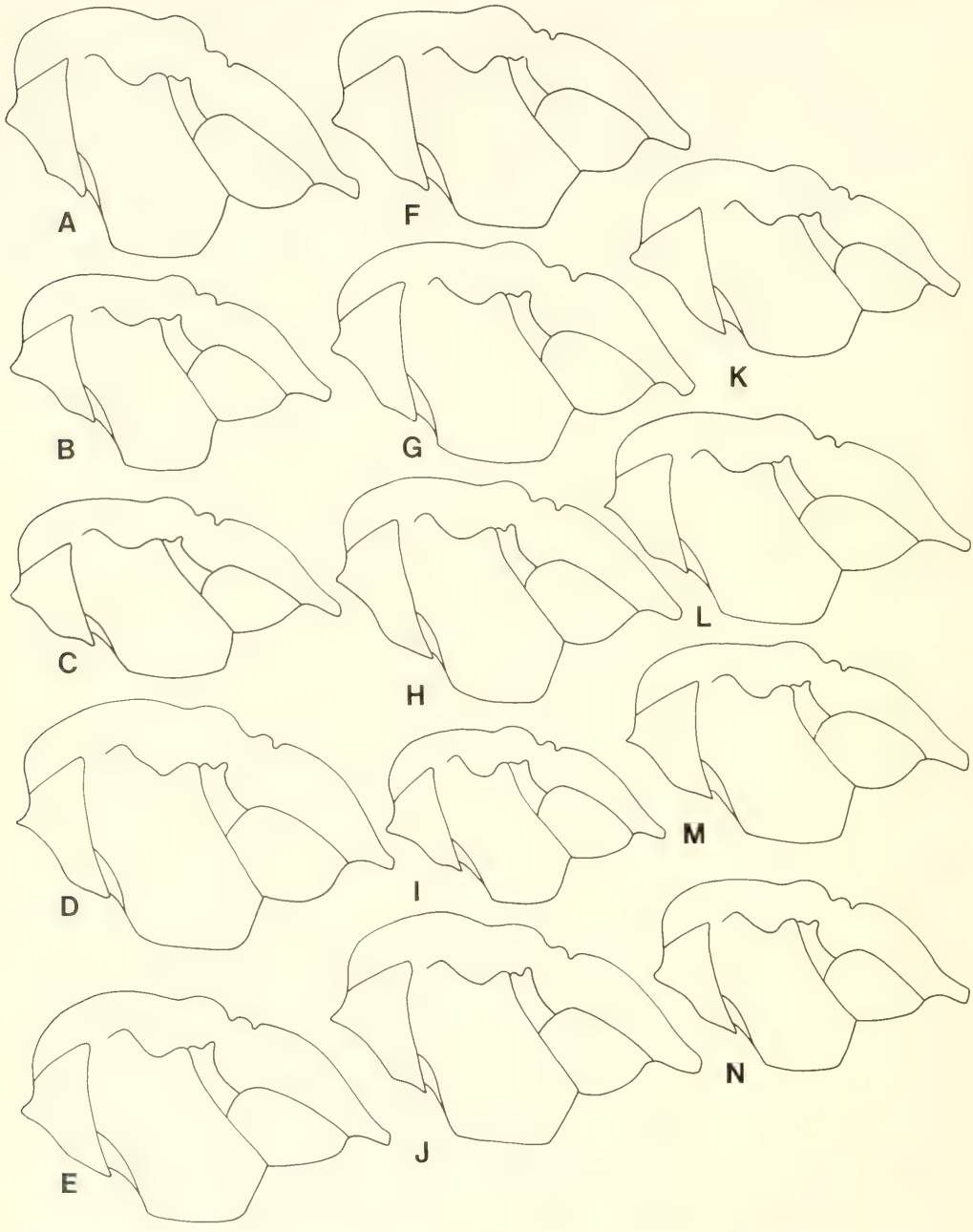

FIGURE 23. Lateral aspect of mesosoma. A. *Venturia pullata* Wahl, B. *V. dreisbachi* Wahl, C. *V. prolixa* Wahl, D. *V. hadra* Wahl, E. *V. portalensis* Wahl, F. *V. latrunculus* Wahl, G. *V. scitula* Wahl, H. *V. micraulax* Wahl, I. *V. longicuspis* Wahl, J. *V. taneces* Wahl, K. *V. sculleni* Wahl, L. *V. platyura* Wahl, M. *V. canescens* (Grav.), N. *V. nickelseni* Wahl.

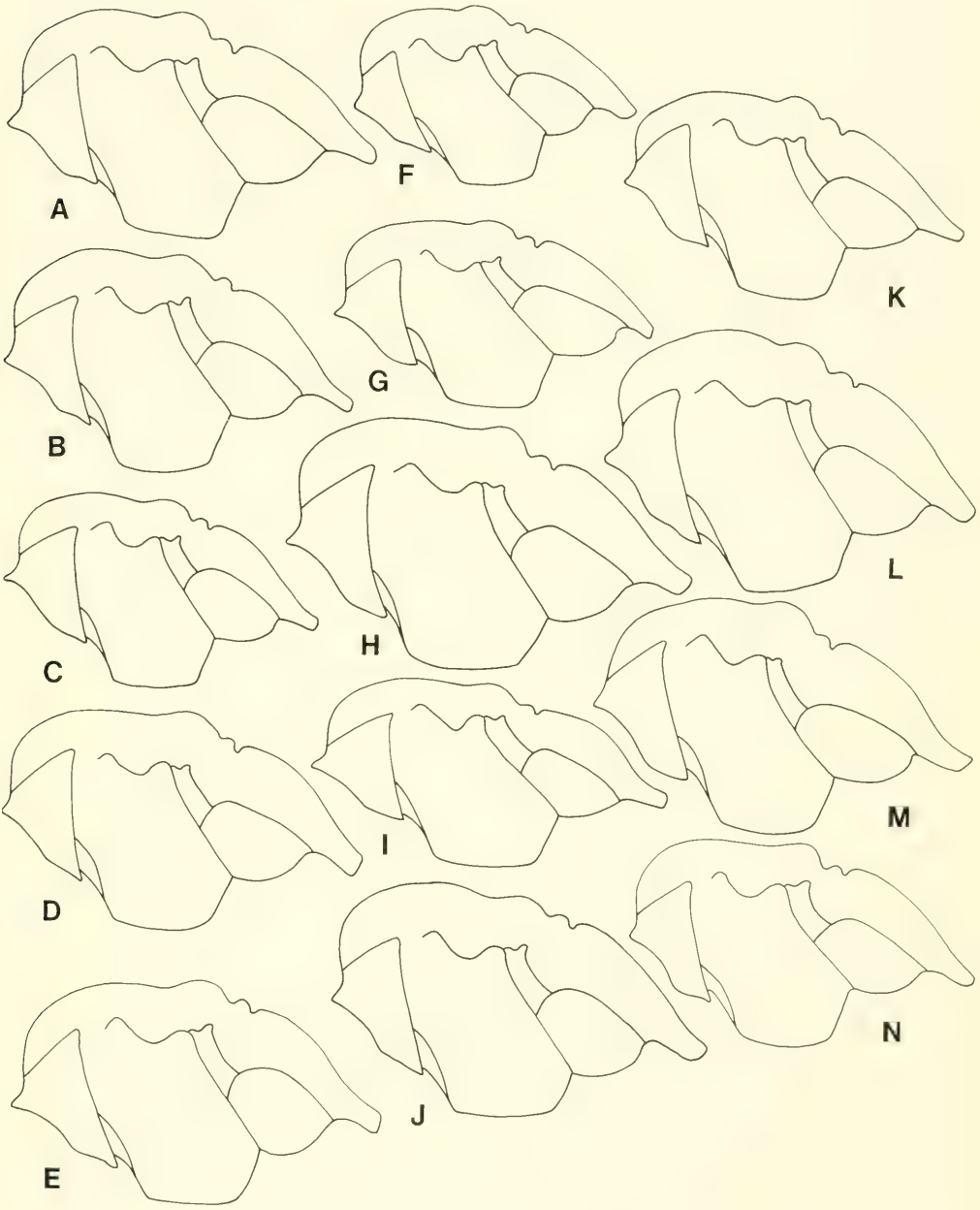

FIGURE 24. Lateral aspect of mesosoma. A. *Venturia hibiscellae* Wahl, B. *V. micheneri* Wahl, C. *V. tristis* Wahl, D. *V. nigricoxalis* (Cush.), E. *V. fuscifemorata* Wahl, F. *V. capulata* Wahl, G. *V. erythropus* (Ash.), H. *V. daschi* Wahl, I. *V. punctata* Wahl, J. *V. finlaysonae* Wahl, K. *V. anchisteus* Wahl, L. *V. sokanakiakorum* (Vier.), M. *V. compacta* Wahl, N. *V. masoni* Wahl.

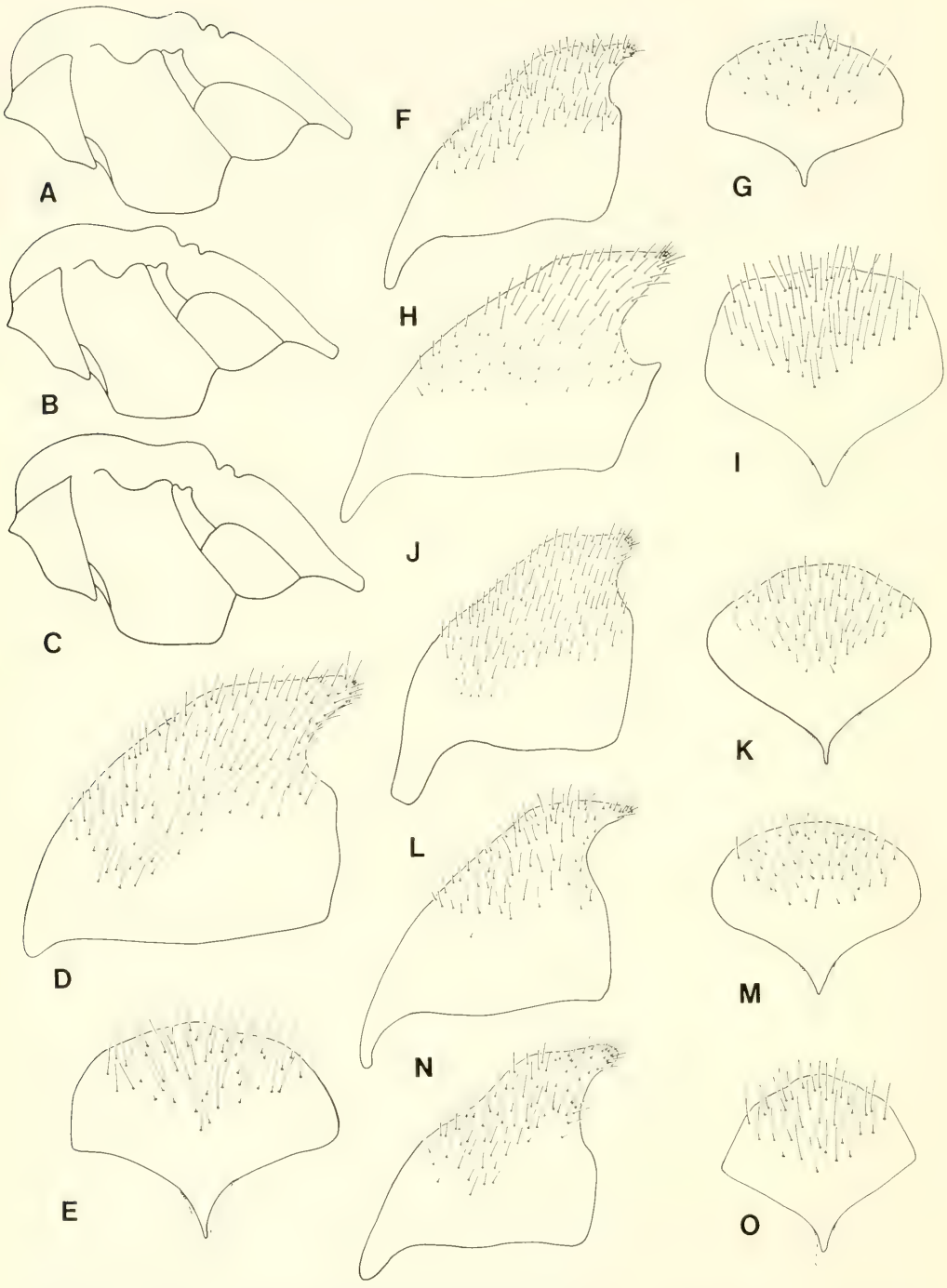

FIGURE 25. **A-C,** Lateral aspect of mesosoma. A. *Venturia licina* Wahl, B. *V. floridensis* Wahl, C. *V. durangensis* Wahl. **D-O,** Right gonoforceps (dorsal aspect) and S9 (ventral aspect). D-E. V. *fuscifemorata* Wahl, F-G. *V. licina* Wahl, H-I. *V. daschi* Wahl, J-K. *V. leptogaster* (Cam.), L-M. *V. platyura* Wahl, N-O. *V. marjoriella* Wahl.

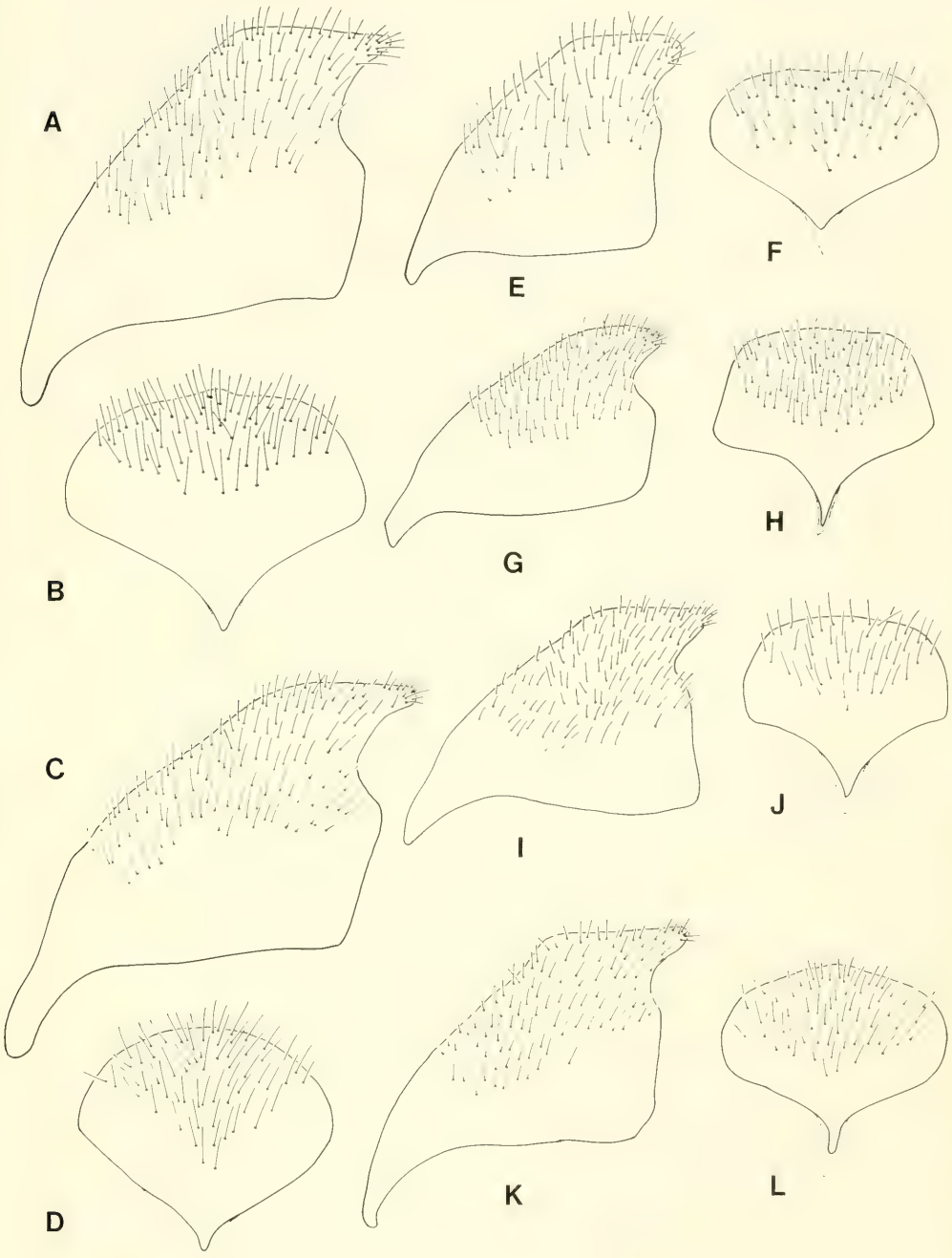

FIGURE 26. Right gonoforceps (dorsal aspect) and S9 (ventral aspect). A-B. *Venturia finlaysonae* Wahl, C-D. *V. hadra* Wahl, E-F. *V. anareolata* Wahl, G-H. *V. micraulax* Wahl, I-J. *V. longicuspis* Wahl, K-L. *V. portalensis* Wahl.

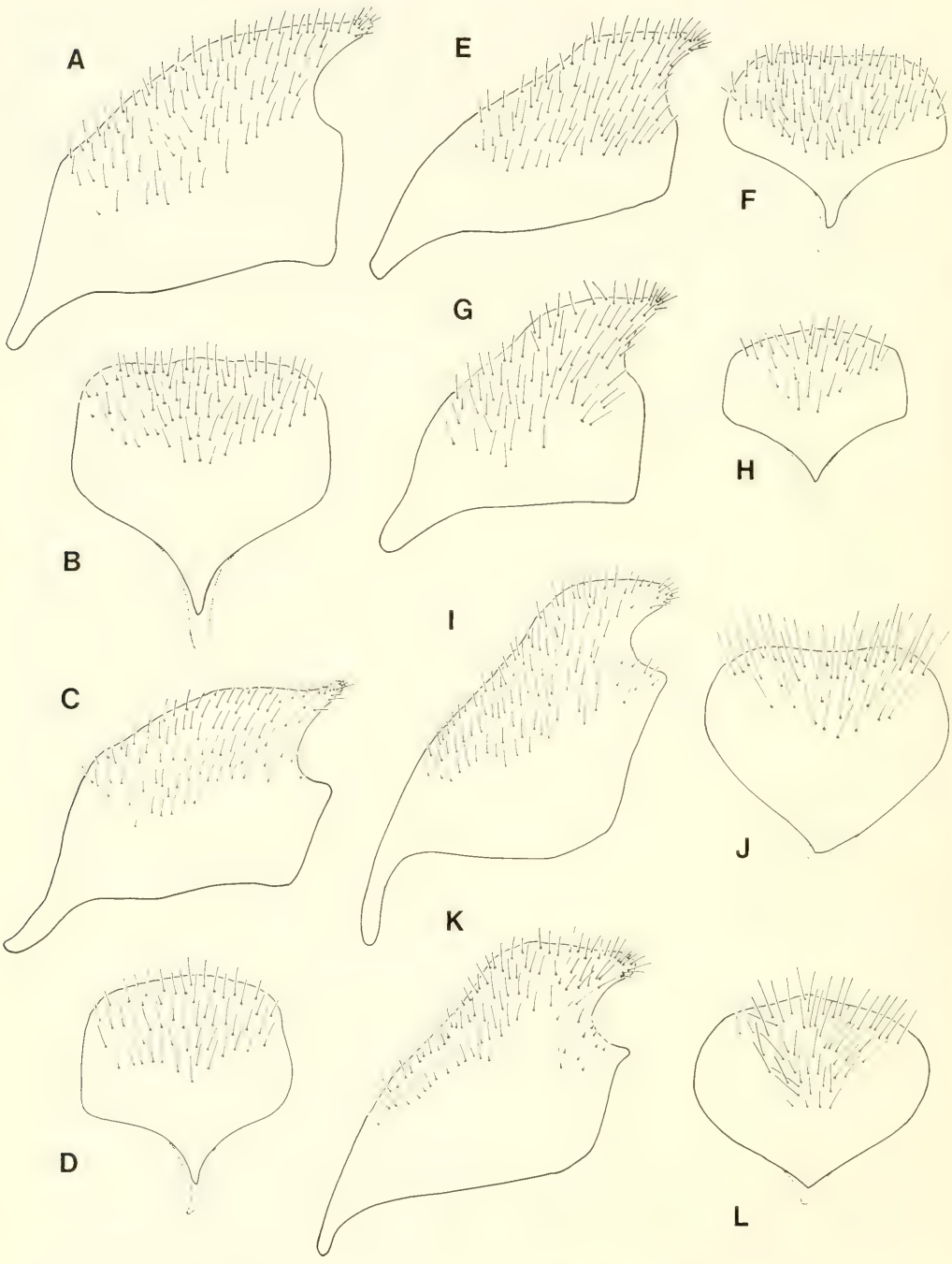

FIGURE 27. Right gonoforceps (dorsal aspect) and S9 (ventral aspect). A-B. *Venturia scitula* Wahl, C-D. *V. scitula* Wahl (Arizona specimen), E-F. *V. sculleni* Wahl, G-H. *V. australis* Wahl, I-J. *V. nigriscapus* (Vier.), K-L. *V. macilenta* (Cress.).

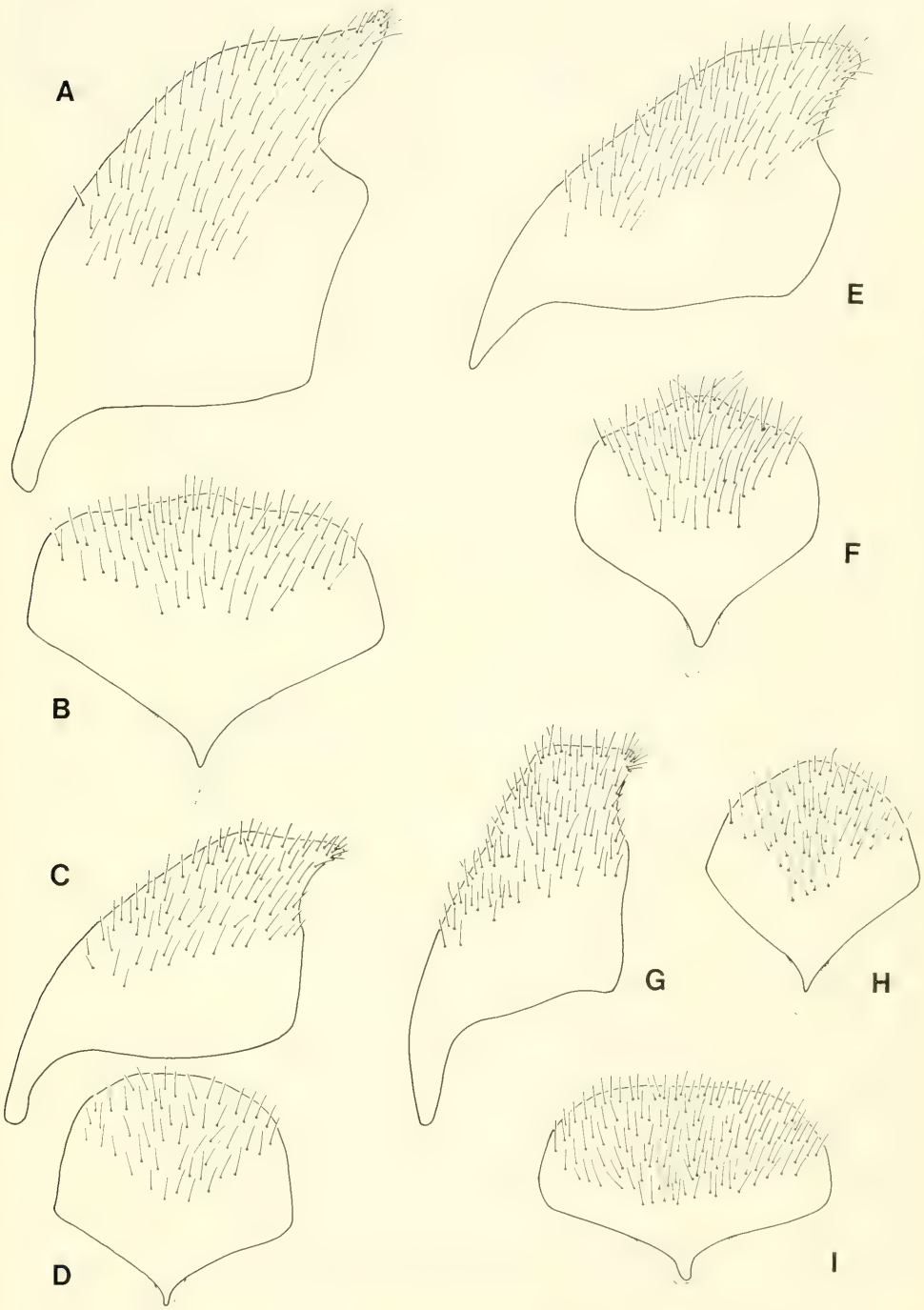

FIGURE 28. A-H, Right gonoforceps (dorsal aspect) and S9 (ventral aspect). A-B. *Venturia erythrogaster* Wahl, C-D. *V. floridensis* Wahl, E-F. *V. nigricoxalis* (Cush.), G-H. *V. sokanakiakorum* (Vier.). I. S9 (ventral aspect) of *V. punctata* Wahl.

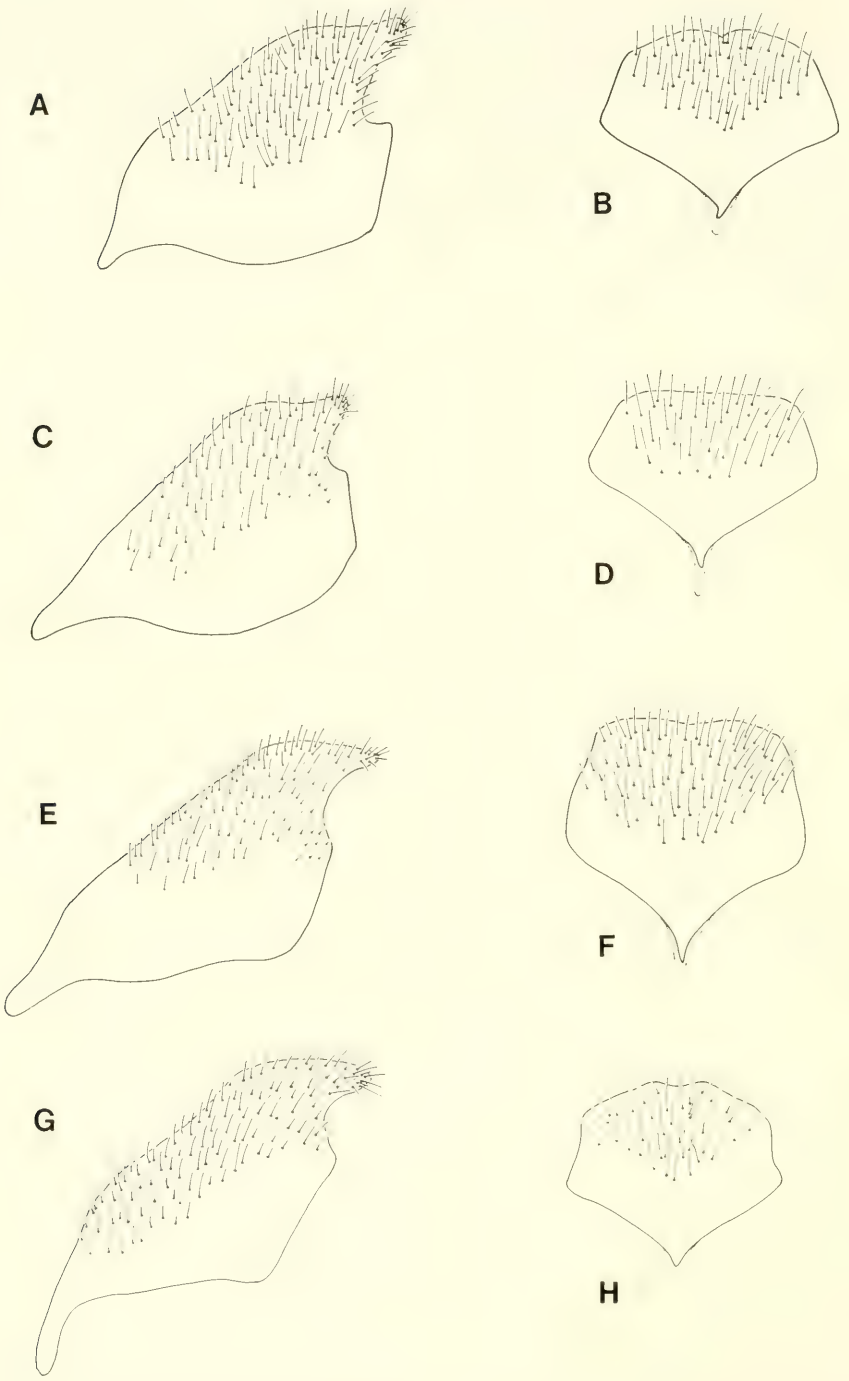

FIGURE 29. Right gonoforceps (dorsal aspect) and S9 (ventral aspect). A-B. *Venturia eremna* Wahl, C-D. *V. amplareolata* Wahl, E-F. *V. erythropus* (Vier.), G-H. *V. masoni* Wahl.

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THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN

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By
Radclyffe B. Roberts and Robert W. Brooks

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Agapostemonine Bees of Mesoamerica (Hymenoptera: Halictidae)

Radclyffe B. Roberts[1] and Robert W. Brooks[2]

Abstract

This work revises Mesoamerican genera and species of agapostemonine Halictini, excepting the recently revised *Agapostemon* and the largely South American *Caenohalictus* and *Habralictus*. An illustrated key and diagnoses are provided for all eight agapostemonine genera occurring from northern México to northern South America. The new monotypic genus, *Agapostemonoides,* is described. The monotypic genera *Rhinetula* and *Paragapostemon* are redescribed. *Dinagapostemon* is raised to generic rank. Cladistic relationships of the *Dinagapostemon* species and of its sister group *Paragapostemon* are analyzed. New species are: *Agapostemonoides hurdi, Dinagapostemon costaricensis, goneus, mentor, mexicanus, orestes,* and *uyacanoides*. New combinations include *D. sicheli, gigas,* and *uyacanus*. The following names are here recognized as new junior synonyms (valid names in brackets): *Rhinetula serraticornis* Friese [= *Dinagapostemon gigas* (Friese)]; *Agapostemon bruneri* Crawford and *Halictus (Paragapostemon) podager* Vachal [= *Paragapostemon coelestinus* (Westwood)]; *Rhinetula rufiventris* Friese [= *Rhinetula denticrus* Friese].

Introduction

This work is intended to contribute to knowledge of the bees of México as part of the *Programa Cooperativo sobre la Apifauna Méxicana* (PCAM). The chief purposes are: (1) description or redescription of Mesoamerican (northern México to eastern Panamá) genera and species; (2) determination of synonymies; (3) presentation of keys and illustrations to facilitate identification, and (4) indication of cladistic relationships of the *Dinagapostemon* species.

In recent years much progress has been made in elucidating taxonomic structure of the subfamily Halictinae. Michener (1978) recognized the distinctive tribe Nomioidini from the Eastern Hemisphere. Eickwort (1969a, b) revised the tribe Augochlorini from the Western Hemisphere, recognizing it as distinct from the cosmopolitan Halictini. He informally recognized what he termed the "*Agapostemon* group" in the Halictini. We agree that agapostemonines are distinct from such American Halictini as *Halictus* s.l., *Lasioglossum* s.l., and *Sphecodes*. Unfortunately, we have been unable to find a character which consistently delimits agapostemonines from other Halictini. In the present study we treat agapostemonines as a distinct group but stopped short of according them status of a tribe.

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We include the following genera among agapostemonines: *Agapostemon* Guérin-Méneville (1844), *Agapostemonoides* new genus, *Caenohalictus* Cameron (1903), *Dinagapostemon* Moure and Hurd (1982), *Habralictus* Moure (1941), *Paragapostemon* Vachal (1903), *Pseudagapostemon* Schrottky (1909), *Rhinetula* Friese (1922), *Ruizantheda* Moure (1964).

South American agapostemonines are poorly known. We have seen a number of undescribed genera and are uncertain of the affinities of *Ruizanthedella* (Moure, 1964) and *Zikaniella* Moure (1941). Evaluation of these genera will have to await a study of South American agapostemonines.

Agapostemon and *Habralictus* aré the only agapostemonines reported from islands of the Caribbean. The only Caribbean *Habralictus* species, *H. claviventris* (Ashmead), was described from St. Vincent in 1900. There are 17 Caribbean species of *Agapostemon.* An additional 21 species are known from Mesoamerica. *Agapostemon* has been revised by Roberts (1972) and is not treated in detail in the present study.

According to Michener (1979) and from Mesoamerican material we have studied, *Caenohalictus* has undescribed representatives in México and Costa Rica. *Habralictus metallicus* (Friese), *H. tradux* (Vachal) and *H. xanthinus* (Cockerell) are the only species of this genus described from Mesoamerica (Moure and Hurd, in press). Because the overwhelming majority of *Caenohalictus* and *Habralictus* species are South American (Alfken, 1932; Moure, 1941), we do not describe Mesoamerican representatives of these genera in the present study.

Many agapostemonine taxa are represented in collections by one or a very few specimens. Doubtless more taxa remain to be described. We hope that collectors will pay special attention to this group; they would do well to focus their efforts on elevations over 2,000 m and to look for females at dawn and dusk. *Rhinetula* is attracted to lights (Janzen, 1968), and light traps at high altitudes might attract *Dinagapostemon.* Little is known of the biology of Mesoamerican agapostemonines. We hope that others will undertake such studies, particularly on details of communal nesting behavior.

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METHODS

For ease of comparison, descriptions of species follow the format and character numbering system used by Roberts (1972). These numbers do not correspond to the character numbers used in our cladistic analysis. The bees we studied are relatively rare in collections and existing descriptions are generally inadequate. We have therefore provided a detailed description of one species in each genus. Other species are described only insofar as they differ from this one species.

We have generally followed the morphological terminology of Michener (1944) except for the new terms (Fig. 1) of *subspiracular carina* (ventrolateral line of Eickwort, 1969b) on metasomal tergum 1 of all halictids, *apicolateral carina* on metasomal tergum 1 of most halictids and *lateral gradular carina* on terga of some halictids.

We depart from the usual terminology applied to the position of structures on legs and follow Roberts (1972). Michener (1978) and others refer to surfaces of legs of bees as "inner" and "outer." This system is morphologically inconsistent because the "inner" region of the posteriorly directed hind leg faces the body while the homologous area of the anteriorly directed foreleg faces outward. Other inconsistencies of the terms "inner" and "outer" become apparent when one considers that the femur and tibia on a single leg are oriented differently from one another. For the sake of morphological consistency, we prefer to think of legs as cylindrical lateral projections orthogonal to a sagittal section of the bee, irrespective of their actual orientation. Thus, we can refer to homologous surfaces as dorsal, ventral, anterior or posterior. Outer and inner hind tibial spurs are, for example, anterior and posterior hind tibial spurs respectively.

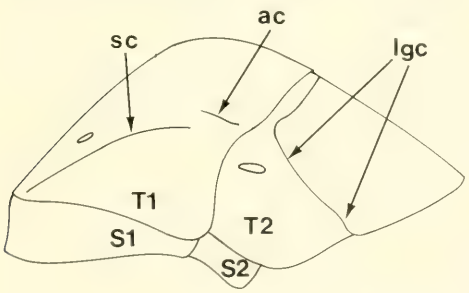

FIGURE 1. Side view of first two segments of metasoma of male *Rhinetula denticrus*. ac, apicolateral carina of T1; lgc, lateral gradular carina; sc, subspiracular carina [ventrolateral line of Eickwort (1969b)]; S, sternum; T, tergum.

Absolute size of various structures is not as important as proportional size. Thus, we have expressed length (unless otherwise indicated) of structures as proportions of easily measured (or estimated) features such as the median ocellar diameter (od). Thus an expression like "pubescence 4 od" means that the hairs are four times as long as the median ocellar diameter. We use the abbreviations S for sternum and T for tergum when referring to segments of the metasoma, e.g., S1 means the first sternum of the metasoma. We have abbreviated male and female as M and F in the data for each species. Abbreviations of names of depositories of specimens are indicated in the Acknowledgements.

CHARACTERIZATION OF AGAPOSTEMONINE BEES

We find no one character state which is both necessary and sufficient to separate *Agapostemon* and allied genera from members of the *Halictus/Lasioglossum* group. Thus, we recognize agapostemonines as a polythetic group of Halictini. Most agapostemonines are easily recognized by a combination of characters (Table 1). Some of these agapostemonine characteristics are behavioral (nest architecture and social organization) or ecological (distribution) and do not lend themselves to keys. As noted in the footnotes to Table 1, some non-agapostemonine Halictini possess certain characteristics of agapostemonines, and certain agapostemonine species are difficult to place because they lack some of the most distinctive features of the group.

CLADISTIC ANALYSIS

We think it premature to put forth a hypothesis on cladistic relationships of included taxa except for species of *Dinagapostemon* and *Paragapostemon*. The cladogram for those genera was made with aid of the computer program PAUP (Swofford, 1984). The rest of the nonparasitic Halictini (including other agapostemonine gen-

era) with strong wing venation, including genera from both Eastern and Western Hemispheres, was considered as the outgroup using ordered, unweighted characters (i.e., 0 = primitive, 1 = derived, 2 or greater = more highly derived characters of a transformation series). Characters 12, 23, 25, etc., (see Fig. 2) were used in the analysis to establish the monophyly of the *Paragapostemon-Dinagapostemon* clade and to bring attention to those characters useful in assessing relationships among agapostemonine genera.

Table 2 is a list of 27 variables relevant to *Dinagapostemon* and *Paragapostemon*. Table 3 shows the raw data. Unique characters for taxa were apomorphies; none agreed with the outgroup, suggesting a plesiomorphy. A cladistic study of the whole agapostemonine group showed that *Dinagapostemon* and its sister group are among the most derived genera (Brooks, unpublished).

Dinagapostemon and *Paragapostemon* share nine apomorphies and each has four unique autapomorphies which distinguish the two genera (Fig. 2). Species of *Dinagapostemon* are quite distinct from one another except *D. mexicanus, sicheli, uyacanoides,* and *uyacanus,* all of which have a patch of long curved setae on the apicolateral margin of S5 (character 18) of males. This group of four species as well as *D. gigas* and *goneus* is further united by the hind tibia of males which possesses a basiventral tooth but is not swollen apically. *D. orestes* lacks five apomorphies present in other species of *Dinagapostemon;* these involve modifications of S4 and S7 and the membranous gonostylar appendage in males. Table 2 includes abbreviated notes on the distribution of variables of characters and the bases for our judgments of polarity (evolutionary direction).

TABLE 1. CHARACTERS OF AMERICAN GROUPS OF HALICTINAE.

CHARACTERS	*AUGOCHLORINI*	*AGAPOSTEMONINES*	*OTHER HALICTINI*
DISTRIBUTION	Western Hemisphere	Western Hemisphere	Cosmopolitan
DIVERSITY MAXIMUM	warm Neotropics	cool Neotropics	Palearctic
SOCIAL STRUCTURE	solitary or eusocial[1]	solitary or communal	solitary or eusocial[2]
NEST ARCHITECTURE	cells next to main burrow, single or in clusters	cells far from main burrow, single or in series	cells next to main burrow single or in clusters[3]
COLOR: HEAD AND THORAX	shiny metallic, rarely black	shiny metallic, rarely black	black, often weakly metallic[4]
COLOR: MALE METASOMA	without yellow maculae	often with yellow maculae	without yellow maculae[5]
MALE HIND TARSOMERES	basal pair articulated	basal pair usually fused	basal pair usually articulated
MALE SPICULUM	present	present in some	absent
MALE VENTRAL RETRORSE GENITALIC LOBE	absent	usually present	usually present
MALE PYGIDIAL PLATE	absent	present	present
FEMALE T5	slit	entire	entire

According to George C. Eickwort (pers. comm.) the following characters occur in certain atypical species of the groups indicated by the footnote numbers: 1, semisocial; 2, semisocial or communal; 3, far from gallery or cells in series; 4, shiny metallic; 5, with yellow maculae.

TABLE 2. VARIABLES USED IN CLADISTIC ANALYSIS OF *DINAGAPOSTEMON AND PARAGAPOSTEMON*. (Apomorphy stated first, plesiomorphy in brackets; characters marked with an asterisk establish monophyly of the *Paragapostemon-Dinagapostemon* clade and denote characters useful in studying the cladistic relationships of other agapostemonine bees.)

1. Malar area well developed, about half as long as wide. [Malar area more or less linear, much less than half as long as wide.] Lengthening of the malar area has occurred several times in Halictini and is an apomorphy. This character is variable in the agapostemonine genus *Caenohalictus,* some species of which have strongly developed malar areas.
2. Antennal flagellum of male modified, sinuate. [Antennal flagellum of male normal, linear.] This peculiar modification of the male antenna is an obviously unique autapomorphy.
*3. Eyes with hair. [Eyes bare or with minute scattered hairs.] *Halictus* and its relatives have eyes bare or with minute scattered hairs; thus, hair on eyes is a derived feature. Most *Agapostemon* have presumably lost eye hair (Brooks, unpublished) but many, especially females, have short, scattered hairs on the eyes.
*4. Propodeum in profile with horizontal basal zone short, about one third as long as declivous surface (1). Propodeum in profile entirely to almost entirely declivous (2). [Propodeum in profile with horizontal basal zone long, about half as long as declivous surface.] Primitive halictids as well as most short-tongued bees have the propodeum angulate in profile with distinct dorsal and declivous surfaces. The evolutionary trend has been toward the entire propodeum becoming declivous, losing the dorsal component.
*5. Hind femur of male with one or more teeth. [Hind femur of male simple.] This attribute has arisen many times in the Halictidae and is obviously a derived feature but is variable in *Agapostemon.* Such teeth, swellings and ridges, quite probably used in gripping the female during copulation, are found on the femur, tibia and basitarsus but occurrence on one part of the leg is not necessarily correlated with occurrence elsewhere on the leg.
*6. Hind femur of male greatly swollen. [Hind femur of male little swollen if at all.] For discussion see character 5.
7. Hind tibia of male with posteroventral basal tooth. [Hind tibia of male without posteroventral basal tooth.] For discussion see character 5.
8. Hind tibia of male swollen apically. [Hind tibia of male not swollen apically.] For discussion see character 5.
9. Posteroventral surface of hind tibia of male with well defined carina (Fig. 17j). [Posteroventral surface of hind tibia of male without well defined carina.] This apomorphy occurs in *Dinagapostemon* but has arisen independently in some *Agapostemon.*
*10. First and second hind tarsomeres swollen and with one or two sharp to blunt teeth. [First and second hind tarsomeres normal, slender and without teeth.] An obvious unique apomorphy uniting *Dinagapostemon* and *Paragapostemon.*
*11. Posterior hind tibial spur of female with six or more large spatulate teeth. [Posterior hind tibial spur of female with three to five large spatulate teeth.] Polarity is based on other strong-veined halictines; those with large teeth have few such teeth.
*12. Stigma moderate in size such that ratio of stigmal length to distance from apex of stigma to apex of marginal cell is 0.6-0.8 (1). Stigma small, such that the above ratio is about 0.5 (2). [Stigma large, such that the above ratio is larger than 0.8.] Among bees there has been an evolutionary trend toward shortening the stigma as well as the marginal cell. Since marginal cell length is practically unchanged among agapostemonine bees, stigmal length presumably reflects this apomorphic change evident by a smaller ratio. It should be noted that this trend may only reflect an increase in body size, since small-bodied bees have relatively large stigmas and large-bodied bees have relatively small ones (Danforth, 1987).
13. T2-T4 with well developed lateral gradular carinae. [T2-T4 without or with very weak lateral gradular carinae.] Well developed lateral gradular carinae are found in *Paragapostemon* and *Rhinetula* but are lacking in most other genera and the outgroup.
14. S4 of male apicoventrally bent. [S4 of male flat.] This derived character is found in all *Dinagapostemon* except *D. orestes.* In most Halictinae S4 of males is flat like S3.
15. Apical margin of S4 of male with large spines. [Apical margin without large spines.] This apomorphy has arisen repeatedly in Halictini but among agapostemonines is limited to most *Dinagapostemon.*
16. Subapical margin of S4 of male with large spines. [Subapical margin without large spines.] See discussion for character 15.
17. Apical margin of S5 of male distinctly emarginate. [Apical margin of S5 of male entire or nearly so.] We are not certain as to polarity of this character but most members of the outgroup have the apical margin of S5 entire.

18. Apicolateral margin of S5 of male with a patch of long curved setae. [Apicolateral margin of S5 of male simple, without a patch of long curved setae.] This character apparently has arisen many times since it is not uncommon among relatives of *Halictus* but most members of the outgroup lack such setae.
19. Medioapical lobe of S7 of male with much long branched hair. [Medioapical lobe of S7 of male, if present, without hair or with a few small simple hairs.] Most Halictini have little or no hair on the medioapical lobe of S7. Among agapostemonine bees almost all *Dinagapostemon* have the apomorphy.
20. Apex of S8 of male with two acute projections separated by an emargination. [Apex of S8 of male with two or three blunt lobes.] This apomorphy, not found in *Halictus* or its relatives, occurs in *Caenohalictus*.
21. S8 of male with spiculum. [S8 of male without spiculum.] One of the diagnostic characters of Halictini is the general loss of the spiculum, but it has presumably been regained apomorphically in five genera of agapostemonine bees.
22. Apex of S8 of male broad and trilobed, with an acute median lobe and blunt lateral lobes. [Apex of S8 of male narrow, entire or bilobed.] This unique apomorphy is characteristic of *Paragapostemon*.
23. Gonostylus of male with elongate membranous appendage. [Gonostylus without elongate membranous appendage.] An elongate membranous gonostylar appendage is an apomorphy not seen in *Halictus* or its relatives.
24. Elongate membranous appendage of gonostylus of male with one serrate edge. [Elongate membranous appendage, if present, simple.] See discussion for 23.

*25. Male genitalia with ventral retrorse lobe. [Male genitalia without ventral retrorse lobe.] We are uncertain as to the polarity of this character. The ventral retrorse lobe is found in some members of the outgroup but may be an apomorphy among agapostemonines.

26. Gonocoxite with striae. [Gonocoxite without striae.] A striate gonocoxite is unusual (although *Sphecodes* and some species of *Halictus* have the striations) and is probably an apomorphy which many agapostemonines possess, though we are not completely certain.
27. S5 of male with V shaped patch of hair apicomedially. [S5 of male simple.] This apomorphy is unique to *D. mentor*.

TABLE 3. DATA USED IN CLADISTIC ANALYSIS OF *PARAGAPOSTEMON AND DINAGAPOSTEMON*.

VARIABLE NO.-	1	2	3	4	5	6	7	8	9	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2
(see Table 2)										0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7
Paragapostemon	1	0	1	1	1	1	0	1	0	1	1	1	1	0	0	0	0	0	0	0	1	1	1	0	1	0	0
D. sicheli	0	1	1	1	1	1	1	0	1	1	1	1	0	1	1	1	1	1	1	0	0	0	1	1	1	1	0
D. uyacanus	0	1	1	1	1	1	1	0	1	1	?	1	0	1	1	1	1	1	1	0	0	0	1	1	1	1	0
D. mexicanus	0	1	1	1	1	1	1	0	1	1	?	1	0	1	1	1	1	1	1	0	0	0	1	1	1	1	0
D. uyacanoides	0	1	1	1	1	1	1	0	1	1	?	1	0	1	1	1	1	1	0	1	0	0	1	1	1	1	0
D. orestes	0	1	1	1	1	1	0	1	1	1	?	1	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0
D. gigas	0	1	1	1	1	1	1	0	1	1	?	1	0	1	1	0	1	0	1	0	0	0	1	1	1	1	0
D. mentor	0	1	1	1	1	1	0	1	1	1	?	1	0	1	1	1	1	0	1	0	0	0	1	1	1	1	1
D. goneus	0	1	1	1	1	1	1	0	1	1	?	1	0	1	1	1	1	0	1	0	0	0	1	1	1	1	0

NOTE: Missing data are indicated by "?".

KEY TO AGAPOSTEMONINE GENERA OF MESOAMERICA

1. Females: 12 antennal segments; hind leg with scopa 2
— Males: 13 antennal segments; hind leg lacking scopa 8
2(1). Eye clothed with erect hairs at least half as long as diameter of median ocellus 3
— Eye glabrous or with minute hairs much less than half as long as diameter of median ocellus . . . 7
3(2). T1 with apicolateral carina (Fig. 1); T2-T4 with lateral gradular carinae (Figs. 1, 7f); metasoma lacking metallic coloration . . . . . *Rhinetula*

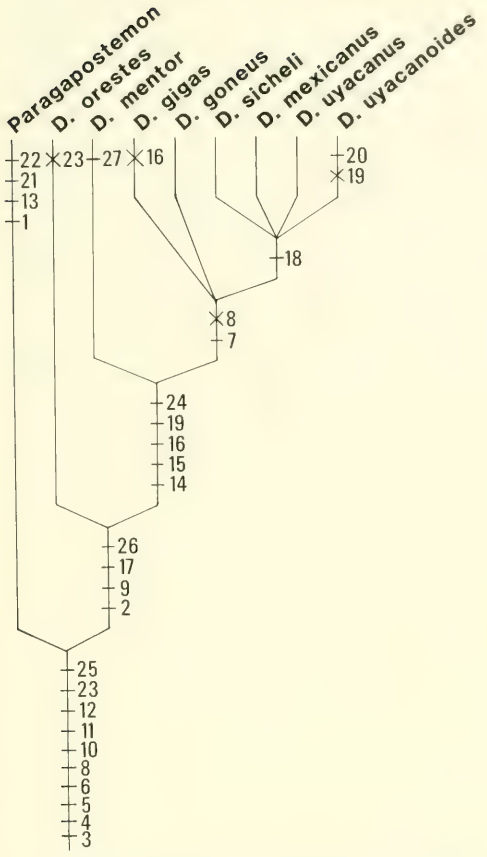

FIGURE 2. Cladogram of *Paragapostemon* and *Dinagapostemon;* bars indicate apomorphies, crosses indicate reversals.

— T1 without apicolateral carina; T2-T4 without lateral gradular carinae or, if carinae present, then metasoma brilliant metallic blue to green 4

4(3′). Hairs on eye subequal to ocellar radius; T2-T4 lacking metallic coloration and with distinct yellow bands . . . . . *Agapostemonoides*

— Hairs on eye subequal to ocellar diameter; metasomal terga usually with metallic coloration basally and lacking distinct yellow bands . . . 5

5(4′). Posterior hind tibial spur with 3 teeth; propodeum glabrous dorsally and about twice as long as metanotum when viewed from above . . . . . *Caenohalictus*

— Posterior hind tibial spur with 6-11 teeth; propodeum hairy dorsally (except for triangle) and subequal in length to metanotum when viewed from above. 6

6(5′). Metasomal terga brilliant metallic blue or green; T2-T4 with distinct lateral gradular carinae (as in *Rhinetula,* Fig. 7f) . . . . . *Paragapostemon*

— Metasomal terga with metallic coloration absent or reduced to inconspicuous basal bands; terga without lateral gradular carinae . . . . . *Dinagapostemon*

7(2′). Posterior surface of propodeum enclosed by distinct carina; body length at least 7 mm; metasomal terga metallic or black to amber, rarely with yellow bands . . . . . *Agapostemon*

— Posterior surface of propodeum without distinct marginal carina; body length at most 6 mm; metasoma black to brown, commonly with distinct yellow maculae or bands, never metallic . . . . . *Habralictus*

8(1′). Eye clothed with erect hair at least half as long as diameter of median ocellus 9

— Eye glabrous or with minute hair much less than half as long as diameter of median ocellus . . . 13

9(8). T2-T4 with lateral gradular carinae (as in Figs. 1, 7f) 10

— Metasomal terga without lateral gradular carinae 11

10(9). Metasoma brilliant metallic green or blue dorsally; propodeum in side view angulate with distinct dorsal and posterior surfaces . . . . . *Paragapostemon*

— Metasoma without metallic coloration; propodeum in side view declivous without distinct dorsal surface. . . . . *Rhinetula*

11(9′). Hind tarsomeres 1 and 2 fused; propodeum hairy dorsally (except for propodeal triangle) and shorter than metanotum when viewed from above; clypeus yellow on lower 0.75 12

— Hind tarsomeres 1 and 2 articulated, free; propodeum glabrous dorsally and nearly twice as long as metanotum when viewed from above; clypeus with yellow restricted to lower margin . . . . . *Caenohalictus*

12(11). T2, T3, and/or T4 with basal or basilateral yellow maculae; hind femur not swollen and lacking posteroventral tooth (Fig. 15e) . . . . . *Agapostemonoides*

— Metasomal terga without yellow maculae; hind femur swollen and with posteroventral tooth (Figs. 15a-d) . . . . . *Dinagapostemon*

13(8′). Metasoma normal, length to apical breadth of T1 is about 0.9, with yellow bands on black to amber terga or, if yellow bands absent, then hind femur swollen, its length to breadth about 1.5; body length at least 6.6 mm . . . . *Agapostemon*

— Metasoma very slender, length to apical breadth of T1 is about 1.9, terga brown, commonly without yellow bands; hind femur slender, its length to breadth about 3.7; body length at most 5.2 mm . . . . . *Habralictus*

AGAPOSTEMON Guérin-Méneville

Agapostemon Guérin-Méneville, 1844, p. 448. Type species: *Apis (Andrena) femoralis* Guérin-Méneville, 1844 (=*Apis viridula* Fabricius, 1793). Monobasic.

DIAGNOSIS: Female head and thorax metallic green and metasoma black, metallic green or amber, or rarely body all black; male head and thorax metallic green and metasomal terga basally yellow, apically black, brown or amber or rarely body all black; eye glabrous or with minute hair much less than 1.0 od; legs of male yellow with some metallic green maculae, rarely all black, hind femur and tibia swollen or slender; hind tarsomeres 1 and 2 of male fused; propodeum with dorsal surface about one-half length of declivous surface; declivous surface enclosed by sharply defined carina; T2-T4 without lateral gradular carinae; T1 of male microareolate below subspiracular carina; gonocoxite usually with striae.

DISCUSSION: Most widespread of the agapostemonine genera, *Agapostemon* ranges from central Canada through Mesoamerica and the Caribbean to northern Argentina. This genus was revised by Roberts (1972) and includes 43 species. Fifteen species are known from Mesoamerica: *A. angelicus* Cockerell, *ascius* Roberts, *atrocaeruleus* Friese, *cockerelli* Crawford, *erebus* Roberts, *intermedius* Roberts, *leunculus* Vachal, *melliventris* Cresson, *mexicanus* Roberts, *nasutus* Smith, *peninsularis* Roberts, *rhopalocera* Smith, *splendens* (Lepeletier), *texanus* Cresson, and *tyleri* Cockerell. Of these, only *A. atrocaeruleus, erebus, mexicanus,* and *rhopalocera* are restricted to Mesoamerica.

Nesting biology of this genus is better known than that of other agapostemonines (Abrams and Eickwort, 1980 and 1981; Eickwort, 1981; Eickwort and Eickwort, 1969; Roberts, 1969). Both solitary and communal behavior have been reported, but eusocial behavior is unknown. Insofar as known, species of *Agapostemon* are all polylectic and their scopae are unspecialized.

AGAPOSTEMONOIDES New Genus

Type species: *Agapostemonoides hurdi* new species.

DIAGNOSIS: About 7-8 mm long; head and thorax metallic green, metasoma of male black with terga basally yellow, metasoma of female with terga dimorphic, either T1 black, T2-T5 on basal third yellow and apical two-thirds amber and T6 amber or T1 all black or with two yellow spots and T2-T5 on basal third yellow and apical two-thirds black and T6 black; malar space linear; hair on eye short, less than 1.0 od; legs of male black, hind basitarsus with tooth, hind tarsomeres 1 and 2 fused; propodeum with distinct dorsal surface about half length of declivous surface; declivous surface enclosed by well defined carina; T2-T4 without lateral gradular carinae, lateral area below subspiracular carina on T1 of male mirror-like, without microsculpturing; S4 of male with six appressed, anteriorly directed, mediosubapical setae; gonocoxite with striae; apex of S8 of male narrowed and weakly trilobed.

DISCUSSION: This monotypic genus is probably closest to *Agapostemon.* Little is known of its habits. Drs. David Roubik, George Eickwort, and RWB have collected females on floral spikes of *Piper* (Piperaceae). Pollen grains of *Piper* are unusually small and, like other bees

which utilize *Piper* as a pollen source (Roberts, 1971; Roberts and Vallespir, 1978), females of *Agapostemonoidses* have very slender, highly branched scopal hairs on the hind femora, trochanters and metasomal sterna. We suspect that this bee is oligolectic on *Piper* and most common in moist forests at low to intermediate elevations where these plants abound.

There are two distinct female color phases with no intermediates. The metasoma may be either black with yellow maculae, as in the holotype, or amber with yellow maculae. The phases are sympatric and often collected together. We are unable to find any morphological differences among females or males. Thus, we regard this as intraspecific variation. Similar variation occurs in some *Agapostemon* species (Roberts, 1972) and other agapostemonines.

The seemingly disjunct distribution of this species (Costa Rica and Panamá vs Perú and Bolivia) may not be real. The moist eastern slopes of the mountains between Panamá and Bolivia have not been well collected. We were not able to find any significant morphological differences between the male collected in Bolivia, the female from Perú and those collected in Central America.

Agapostemonoides hurdi new species

ETYMOLOGY: We dedicate this species to a devoted student of the Apoidea, the late Paul D. Hurd, Jr.

TYPES: Male holotype (KU) from *PANAMÁ,* COLÓN PROV.: Pipeline Road, km 8 near Gamboa (Canal Zone), 28 March 1981, on *Piper,* R. W. Brooks. Female allotype and 1F paratype labeled as holotype but 2 May 1981 (RWB). Additional paratypes, all from PANAMÁ: COLÓN PROV.: 30 km SE of Colón (Santa Rita Ridge), 13 May 1981, on *Psychotria,* R. W. Brooks, 1F, 2M (RWB); Parque Nacional Soberania, Pipeline Road, N of Gamboa, 9 Oct. 1981, D. Roubik, 5F (STRI); same data except collected at km 8 (type locality), on 8 Oct. 1982, collection no. 114, (1F STRI, 2F KU); same data but no host plant, 8 Dec. 1980 between 1000-1200 h, 2F (STRI); same data but no host plant, 11 Feb. 1982, collection no. 112, 1F (STRI); same data but collected 6 Apr. 1981, on *Piper,* R. W. Brooks, 1M (RWB); same data but no host plant, collected at km 13, 13- 25 Aug. 1979, 2F (STRI); same data but collected 12 Sept. 1980, on *Piper,* 4F (STRI). PANAMÁ PROV.: Cerro Campana, near Capira, 12 Apr. 1980, D. Roubik (2M KU, 5M STRI); same data but collected 7 Sept. 1981, collection no. 3, 1F (STRI); same data but collected at 1000 m, 7 May 1981, on *Clethra lanata,* 7M (RWB). SAN BLAS PROV.: 1.3 km W of Mulatupo Sasardí, 10 Sept. 1981, collection no. 9, D. Roubik, 1F (STRI).

ADDITIONAL SPECIMENS: *BOLIVIA:* DPTO. SANTA CRUZ: 5 km W of Buena Vista, 400 m, 18 Feb. 1976, R. B. Roberts, 1M (REM). *COSTA RICA:* CARTAGO PROV.: Turrialba, 600 m, 17 July-29 Aug. 1965, G. C. and K. Eickwort, 1M and 4F (CU); same data except 12 Sept. 1964, R. B. and G. Roberts, 4M (REM). SAN JOSÉ PROV.: Santiago de Puriscal, 1000 m, C. D. Michener, 4M (KU). *PERÚ:* HUÁNUCO PROV.: Huánuco Dpto.: Tingo María, Dec. 1949, H. A. Allard, 1F (USNM).

DESCRIPTION: *MALE* (Figs. 3i, 4a, 6a, 10a, 14a, 15e, 17k, 18a, 19a-b). General color of head and thorax bright metallic green with yellow on clypeus, labrum and mandibles, metasoma brownish black with yellow bands, length about 7 mm. HEAD (Figs. 4a, 6a): Pubescence white on gena and around antennal sockets, amber to brown elsewhere. (1) Labrum: Yellow basally, becoming transparent amber distally; distal margin with fimbria of golden hairs 0.8 od. (2) Clypeus: Yellow on lower 0.4, metallic above; large punctures separated by several times their diameters; pubescence 0.8 od centrally, becoming longer (1.8 od) peripherally. (3) Interocular area: Flat above antennal sockets and with distinct supraclypeal bulge below antennal sockets; punctures minute and contiguous above antennal sockets, becoming coarser below; pubescence erect, nearly as long as scape medially, becoming short laterally and ventrally. (4) Vertex: Metallic; ocellar separation 0.4 od, lateral ocellus 1.7 od from eye, surface between eye and lateral ocellus concave, region behind ocelli gently convex and bordered posteriorly by preoccipital carina; minute contiguous punctures anteriorly and laterally, becoming rugose posteriorly; pubescence 1.3 od. (5) Gena: Metallic; area behind eye slightly concave; weakly striate; hypostomal carina 3.3 times as long as width of proboscidial fossa; pubescence 3.5 od posteromedially, becoming shorter anteriorly and laterally. (6) Malar area: Amber; 0.2 od between eye and mandibular base. (7) Mandible: Yellow with apical third transparent reddish brown; without tooth or ridges; sparse golden hairs 2.5 od proximoventrally, becoming shorter distally. (8) Antenna (Fig. 3i): Scape, pedicel and dorsum of flagellum piceous, flagellum amber ventrally. THORAX: Metallic green; pubescence amber dorsally, becoming creamy laterally, posteriorly and ventrally. (9) Pronotum: Lateral angle prominent but lacking sharp edge anteriorly, posterior lobe rounded; minutely rugose; pubescence 2.0 od on posterior lobe, becoming short ventrally and anteriorly. (10) Mesoscutum: Anterior margin abruptly declivous; uniformly covered with deep, contiguous punc-

tures; pubescence 0.8 od, uniformly distributed. (11) Mesoscutellum: Punctures like those on mesoscutum but slightly coarser and with small, shiny, impunctate area near midline; pubescence 2.5 od centrally. (12) Metanotum: Coarsely rugose; pubescence like that of mesoscutellum. (13) Mesepisternum: Rugose anteroventrally, becoming contiguously punctate posterodorsally; pubescence 1.4 od. (14) Metepisternum: Finely rugose; pubescence 1.5 od. (15) Propodeum: Punctate anteriorly, becoming coarsely rugose posteriorly and dorsally, posterior surface enclosed by prominent carina, large medial groove on posterior surface nearly reaching carina dorsally; pubescence 0.7 od laterally, becoming 1.6 od posteromedially. (16) Wings: Clothed with minute, brown hairs about as long as diameter of adjacent veins distally, becoming longer (0.4 od) proximally, veins and stigma dark brown, 7-9 hamuli on hind wing. (17) Tegula: Transparent brown, often metallic anteromedially; covered with small appressed hairs anteriorly, glabrous posteriorly. (18) Foreleg: Coxa metallic laterally; pubescence 2.2 od. Trochanter dark amber; pubescence 2.0 od dorsolaterally, shorter anteroventrally. Femur amber; pubescence branched and 1.6 od posteroventrally, simple and 0.9 od anterodorsally, glabrous anteroventrally and posterodorsally. Tibia yellowish amber anteriorly, becoming dark amber to black posteriorly; pubescence simple, 1.9 od anteriorly, 0.4 od posteriorly, short elsewhere; strigilis with transparent velum and yellowish amber malus 2.0 od long. Tarsus yellowish amber; basitarsus 0.8 as long as tarsomeres 2-5 together; covered with bristles 0.6-1.4 od. (19) Middle leg: Similar to foreleg but coxa nonmetallic. Tibial spur 1.5 od long and basitarsus 1.1 times as long as tibia. (20) Hind leg (Figs. 15e, 17k): Color and pubescence similar to those of foreleg. Femur with posteroventral tooth. Tibia with anterior spur 2.2 od and posterior spur 2.7 od. Tarsus with fused tarsomeres 1 + 2 1.4 times as long as tarsomeres 3-5 together. METASOMA: (21) Terga: Brown to black with yellow bands or markings basally on

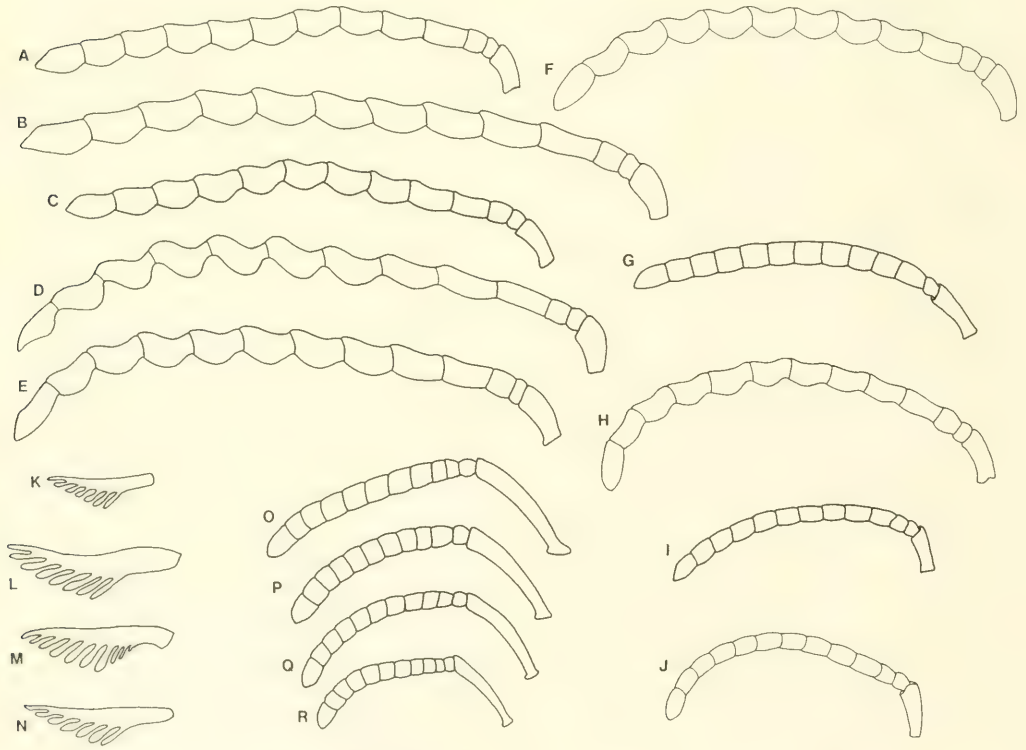

FIGURE 3. A-K, male antennae; L-O, female posterior hind tibial spurs; P-S, female antennae. **A,** *Dinagapostemon gigas;* **B,** *D. mentor;* **C,** *D. mexicanus;* **D,** *D. orestes;* **E,** *D. uyacanus;* **F,** *D. sicheli;* **G,** *Paragapostemon coelestinus;* **H,** *Dinagapostemon goneus;* **I,** *Agapostemonoides hurdi;* **J,** *Rhinetula denticrus;* **K,** *Agapostemonoides hurdi;* **L,** *Dinagapostemon sicheli;* **M,** *Paragapostemon coelestinus;* **N,** *Rhinetula denticrus;* **O,** *Dinagapostemon sicheli;* **P,** *Paragapostemon coelestinus;* **Q,** *Rhinetula denticrus;* **R,** *Agapostemonoides hurdi.*

T2-T3, T2-T4 or T2-T5. T1 with large deep punctures separated by about their diameter on all but posterior margin, punctures progressively smaller on subsequent terga, pygidial plate with rounded margin (Fig. 14a); pubescence 1.2 od and white anteriorly on T1, becoming 2.0 od and brown on T6. (22) Sterna (Fig. 10a): Amber with short, white, appressed pubescence. S4 with 4-5 small, appressed, anteriorly directed spines centrally (difficult to see). S7 and S8 (Fig. 18a). (23) Genitalia (Figs. 19a-b).

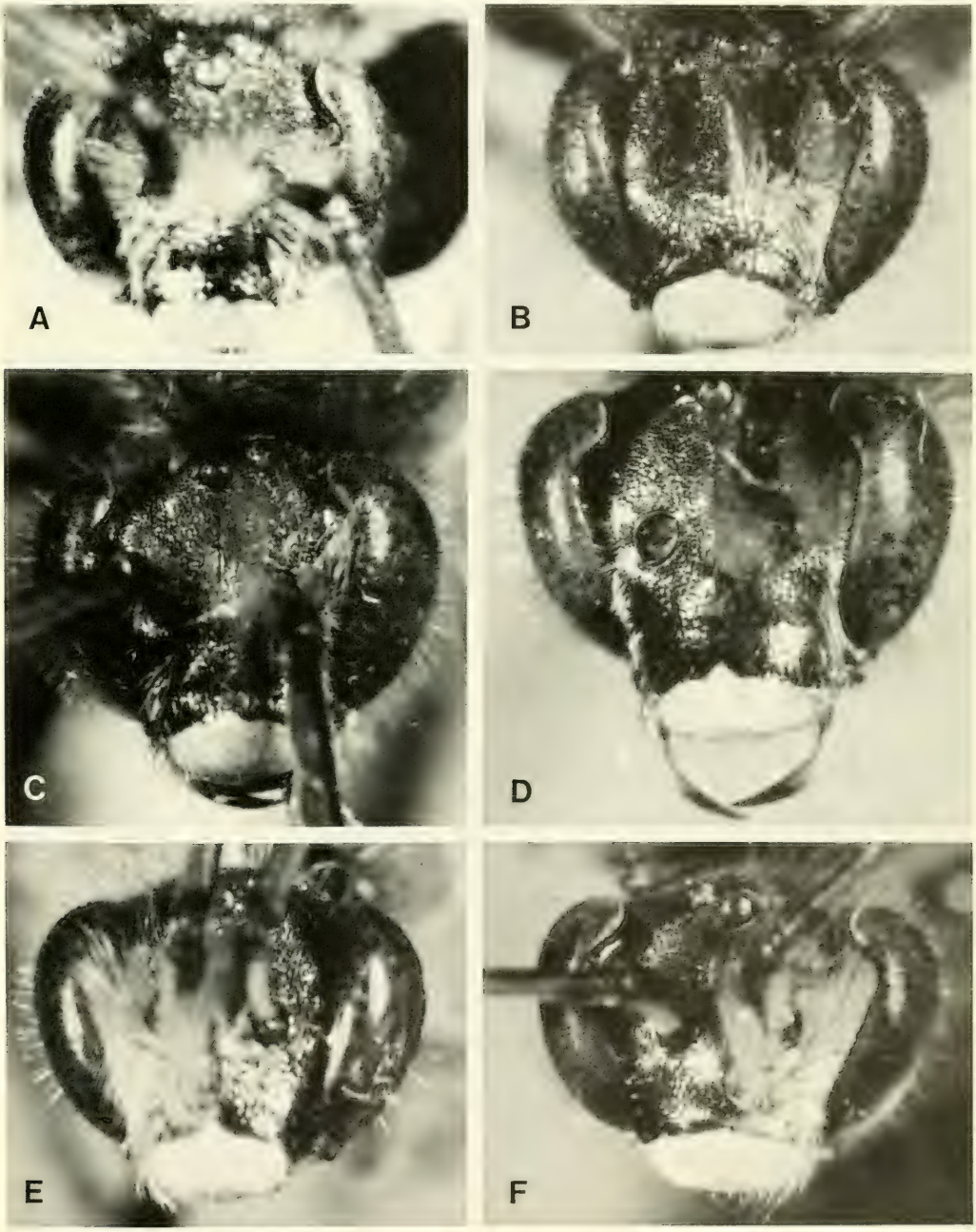

FIGURE 4. Male heads in front view. **A,** *Agapostemonoides hurdi;* **B,** *Dinagapostemon goneus,* holotype; **C,** *D. gigas,* lectotype; **D,** *D. mentor,* holotype; **E,** *D. mexicanus,* holotype; **F,** *D. orestes,* holotype.

FEMALE (Figs. 3k, r, 5f, 9a, 13a-b). Unless otherwise described, female like male. General color of head and thorax metallic greenish black, metasoma black or brownish yellow with yellow bands basally on T2-T4 or T2-T5, pubescence brownish black, length about 8 mm. HEAD (Figs. 5f, 9a): Pubescence white on gena and around antennal sockets, brownish black elsewhere. (1) Labrum: Dark amber; basal area prominent, convex and rough medially, becoming concave and smooth anterolaterally, margin flanged; distal process with distal, median keel, conspicuous lateral projection and marginal fimbria of amber upturned bristles. (2) Clypeus: Black with metallic tints on dorsal and lateral margins, coarsely punctate; pubescence scattered, 0.5-3.3 od, fimbria of bristles bent ventrad (2.4 od) between lateral teeth on distal margin. (3) Interocular area: Finely rugose; pubescence 1.0 od between antennal sockets, longer (3.4 od) laterally. (4) Vertex: Ocellar separation 0.8 od, lateral ocellus 2.4 od from eye. (5) Gena: Area behind eye convex; finely striate; hypostomal carina 1.4 times as long as proboscidial fossa; pubescence 1.7 od posteromedially, becoming shorter anteriorly and laterally. (7) Mandible: Amber; with subapical tooth; sparse, brown hair 3.9 od proximoventrally, becoming shorter distally. (8) Antenna (Fig. 3r): Piceous, becoming amber on underside and apex of flagellum. THORAX: (11) Mesoscutellum: Punctures finer than those of mesoscutum, without shiny impunctate areas. (14) Metepisternum: Fine horizontal rugae. (16) Wings: 8-11 hamuli on hind wing. (18-20) Legs: Brown to black; pubescence typical of female Halictinae but with comb of close set black bristles 1.4 od on posterior margin of fore tarsus and with scopal hairs very finely branched and present on fore and mid trochanters in addition to usual location on hind leg; posterior spur on hind tibia with 5-6 flattened teeth (Fig. 3k). METASOMA: (21) Terga: With yellow bands basally on T2-T4 or T2-T5, background brownish yellow or black (Figs. 13a-b); surface impunctate but dull and nonreflective; pubescence short (1.4 od) and pale anteriorly on T1, short black bristles laterally on all terga and in transverse band on subapical third on T3-T5 though often interrupted medially on T3 and T4, bristles long (2.9 od) in vicinity of amber or black prepygidium. (22) Sterna: Amber with moderately dense, branched hairs forming secondary scopa.

CAENOHALICTUS Cameron

Caenohalictus Cameron, 1903, p. 231. Type species: *Caenohalictus trichiothalmus* Cameron, 1903. Monobasic.

DIAGNOSIS: Length about 4-11 mm; female head and thorax metallic green to blue or brassy, rarely metallic red or non-metallic black to dark brown; terga of metasoma with slight metallic green to blue highlights basally to brillant metallic; sterna dark non-metallic; eyes with hair at least 1 od, often 2 or 3 od; male like female except often labrum and apical third or less of clypeus bright to pale yellow; some species have normal females but males with prolonged faces; hind tibia of male almost parallel-sided, rarely apically expanded, hind tarsomeres 1 and 2 of male articulated; propodeum with dorsal surface about as long as declivous surface which is not enclosed by carinae, propodeal triangle apically shining, almost mirror-like with some basal longitudinal striae, to dull and closely punctate; metasomal terga lacking lateral gradular carinae (usually true of smaller species, 4-6 mm) to T2-T5 with well developed lateral gradular carinae (usually found in species from 7-11 mm in length); T1 of male microareolate below subspiracular carina; striae absent on gonocoxite.

DISCUSSION: Species of *Caenohalictus* are widespread in México (Michener, 1979), occurring southward from the states of San Luis Potosí and Nayarit. There is one described species from Honduras [*C. elachion* (Vachal), (Moure and Hurd, in press)] and several undescribed species from México and Costa Rica.

The nests of *C. rostraticeps* [reported as a *Halictus* by Claude-Joseph (1960)] and *C. eberhardorum* (Michener, Breed, and Bell, 1979) have been found. The former constructs cell clusters while the latter places single cells at the ends of long laterals. The question of degree of sociality found in *Caenohalictus* is the same as *Habralictus*. Lone females or small communal colonies are found in vertical banks, sometimes in dense aggregations. In a nest containing two or more bees, all females have enlarged ovaries so they may be quasisocial or only communal.

FIGURE 5. A-E, male heads in front view; F, female head in front view. **A,** *Dinagapostemon sicheli;* **B,** *D. uyacanus;* **C,** *D. mentor,* holotype; **D,** *Rhinetula denticrus;* **E,** *Paragapostemon coelestinus;* **F,** *Agapostemonoides hurdi.*

A
B
D
E
F

DINAGAPOSTEMON Moure and Hurd new status

Paragapostemon (Dinagapostemon) Moure and Hurd, 1982, p. 46. Type species: *Halictus (Agapostemon) sicheli* Vachal 1901. Original designation.

DIAGNOSIS: Length about 11-14.5 mm; metallic green or blue to nonmetallic brown to amber; malar space linear; hair on eye more than 1.0 od; antenna of male crenulate to sinuate, flagellomere 1 about equal in length to flagellomere 2 in female; legs of male dark brown to black with some amber and occasional metallic hue, hind leg swollen with femoral, tibial and basitarsal teeth, hind tarsomeres 1 and 2 fused; propodeum almost entirely declivous with practically no dorsal surface; T2-T4 with no lateral gradular carinae; lateral area below subspiracular carina on T1 of male mirror-like with some fine areolate sculpturing; gonocoxite with striae, gonostylus with long membranous appendage serrate along outer edge; apex of S8 of male entire to bilobed.

DISCUSSION: Members of this genus were formerly included in *Paragapostemon.* We believe the following differences warrant recognition of *Dinagapostemon* as a separate genus. In contrast to *Paragapostemon, Dinagapostemon* has more complex male genitalia (Figs. 19c-h, 20a-j), sinuate [not "twisted in a spiral" (Moure and Hurd, 1982)] male antennae (Figs. 3a-f, h), toothed male hind femora (Figs. 15a-d, f, 16a, c), and lacks distinct lateral gradular carinae on anterior metasomal terga of both sexes. No *Dinagapostemon* females have the brilliant metallic metasomal terga of *Paragapostemon.*

Dinagapostemon species have been collected in moist montane habitats between 1,000 and 2,400 meters elevation. Nothing is known of their habits. Three of the species are known from single males. Although we are reluctant to describe species from unique specimens, the rarity of these bees leaves us little choice. The disjunct nature of their habitat leads us to expect that further exploration of moist highland areas will yield additional species.

Association of sexes, often a difficult problem in agapostemonines, has proved intractable in *Dinagapostemon.* Excepting *D. gigas* and *D. sicheli,* males and females have not been taken from the same localities. Females vary considerably in color of integument and pubescence. Variation is almost as great within localities as between localities. It is quite likely that there are undescribed species among females we have examined, but we have decided not to describe them without associated males (except *D. costaricensis)* because: (1) we are unable to distinguish them on the basis of stable morphological characters; (2) some of them may be conspecific with described males.

Dinagapostemon sicheli is fully described because it is least rare and both sexes are known.

KEY TO SPECIES OF DINAGAPOSTEMON

1. Males; antenna with 11 flagellomeres; scopa absent 2
— Females; antenna with 10 flagellomeres; scopa present . . . . . *costaricensis, gigas, sicheli*
2(1). Margin of S4 appressed, not bent ventrally (Fig. 10f) or margin bent ventrally with only one row of long curved spines 3
— Margin of S4 bent ventrally with two rows of hooked spines (Figs. 10e, g, h) 4
3(2). Margin of S4 bent ventrally, with single row of low curved spines; anterior hind tibial spur less than 0.5 as long as posterior spur, posteroventral surface of hind tibia with basal tooth . . . . . *gigas*
— Margin of S4 appressed, not bent ventrally, without spines; anterior hind tibial spur more than 0.75 as long as posterior spur; posteroventral surface of hind tibia without basal tooth. . . . . *orestes*
4(2′). Scape piceous ventrally; S5 without tuft of hairs emerging from beneath posterolateral margin of T5 (Fig. 10c) 5
— Scape yellow to amber ventrally; S5 with tuft of 3-6 long, golden, lateral hairs which curl anterad from beneath posterolateral margin of T5 (Fig. 10g) 6
5(4). Hind trochanter without conspicuous ventral projection (Fig. 14k); fused hind tarsomeres 1 + 2 with ventral tooth closer to base than apex (Fig. 17b); thorax metallic green dorsally and blue laterally . . . . . *goneus*
— Hind trochanter with conspicuous ventral projection (Fig. 14l); fused

hind tarsomeres 1 + 2 with ventral tooth closer to apex than base (Fig. 17c); thorax metallic green dorsally and laterally. . . . . *mentor*

6(4'). Thorax metallic green or bluish green dorsally and laterally; distilateral angle of gonostylus with setae subequal in length to width of penis valve. 7

— Thorax metallic green dorsally and blue laterally; distilateral angle of gonostylus with setae less than 0.3 as long as width of penis valve apex (Figs. 20a, b) . . . . . *mexicanus*

7(6). Hind trochanter with ventral keel 0.35-0.40 as deep as long (Fig. 14q); penis valve with narrow dorsal crest (Fig. 20i). 8

— Hind trochanter with ventral keel 0.45-0.50 as deep as long (Fig. 14p); penis valve with broad dorsal crest (Fig. 20f). . . . . *sicheli*

8(7). Medioapical projection of S7 with several long, branched hairs (Fig. 18h); apex of S8 with two large obtuse lobes (Fig. 18h) . . *uyacanus*

— Medioapical projection of S7 without hair (Fig. 18i); apex of S8 with two small acute lobes (Fig. 18i) . . . . . *uyacanoides*

Dinagapostemon sicheli (Vachal) new combination

Halictus (Agapostemon) sicheli Vachal, 1901, p. 77. Male lectotype (MNHN).

Nomia tacita Cameron, 1902, p. 376. Male holotype (BMNH).

TYPES: Male lectotype of *Halictus sicheli,* here designated, is "du Mexique" as recorded on the label and in the description by Vachal (1901).

The male holotype of *Nomia tacita* is labeled New Mexico, Cameron, 1902. Although the label gives the locality as New Mexico, this species has not been collected near New Mexico. In all probability, the label is in error (Hurd and Linsley, 1976). Genitalia glued to label are not those of *Nomia tacita* although genitalia have been removed from the specimen. Genitalia associated with the specimen appear to be from a specimen of *Paragapostemon coelestinus* (Westwood).

DISTRIBUTION: This is the only species of *Dinagapostemon* which has been collected on more than three occasions. Even so, only six people have collected specimens since 1871. Most of 41 known specimens are from eastern México. *MÉXICO:* VERACRUZ: 7 km S of Coatepec, 5 Aug. 1962, on *Cucurbita,* R. F. Smith, 1 F (UCB); Córdoba, 1867, O. Sichel, 1 M (BMNH); 3.2 km W of Fortín de la Flores, on *Cucurbita martinezi,* 23 Jul. 1962, 0706 h, D. Janzen, R75-2, 1 F (UCB) and R75-0, 1 F (KU); same as preceeding locality but 6 Aug. 1962, P. D. Hurd, Jr., on mint, 1 F (UCB); Jalapa, 6 Jun. 1871, Bilimek col., 1 M (NMV); Jalapa, 28 Sept.-3 Oct. 1961, R. and K. Dreisbach, 2 M (MSU and KU); 8 km S of Jalapa, 5 Aug. 1962, on *Cucurbita moschata,* P. D. Hurd, Jr., 1 F (UCB); Orizaba, Biart, 1 F (BMNH); Orizaba, 1867, O. Sichel, 3 M (BMNH); Orizaba, 5 May 1871, Bilimek, 2 M and 2 F (NMV); Orizaba, 25 Jul. 1956, R. and K. Dreisbach, 1 M (MSU); Orizaba, 12-22 Aug. 1961, R. and K. Dreisbach, 3 M (MSU); Teocelo, Santa Rosa, 14 Aug. 1982, J. S. Moure and R. Ayala, 1 M (UNAM). OAXACA: 38.6 km S of Valle Nacional, 1700 m, 24-25 Jul. 1970, E. Fisher and P. Sullivan, 1 M (LACM). TAMAULIPAS: Rancho Cielo, 11.2 km W of Gómez Fárias, 4-6 Nov. 1972, J. E. Gillaspy, 2 M (UTAH). Fourteen additional specimens in the British Museum collected in 1867 (Sichel collection); 9 M and 5 F without localilty data. We have seen other specimens from unspecified localities in México: 1 M, 1868, Bollard col. (OX); 7 M (NMV).

DESCRIPTION: *MALE* (Figs. 3f, 5a, 7a, 10g, 14g, p, 16a, 17f, 18g, 20e-g). General coloration metallic green. Length about 12.5 mm. HEAD (Figs. 5a, 7a): Pubescence creamy to pale yellow. (1) Labrum: Yellow, impunctate, distal margin with fimbria of golden hairs 0.7 od. (2) Clypeus: With yellow at midline occupying 0.8 clypeal length, yellow extending above basal margin of elevated, beveled, flattened area; punctures large, shallow and widely separated; pubescence simple and short (0.8 od) centrally, becoming branched and longer (1.9 od) dorsally and laterally. (3) Interocular area: Metallic except for piceous paraocular strip 0.5 od wide ventrally and 1.0 od wide dorsally; surface concave in paraocular area and below median ocellus, distinct supraclypeal bulge below and between antennal sockets, prominent medial tooth (frontal tubercle) just below antennal sockets; punctures minute and contiguous

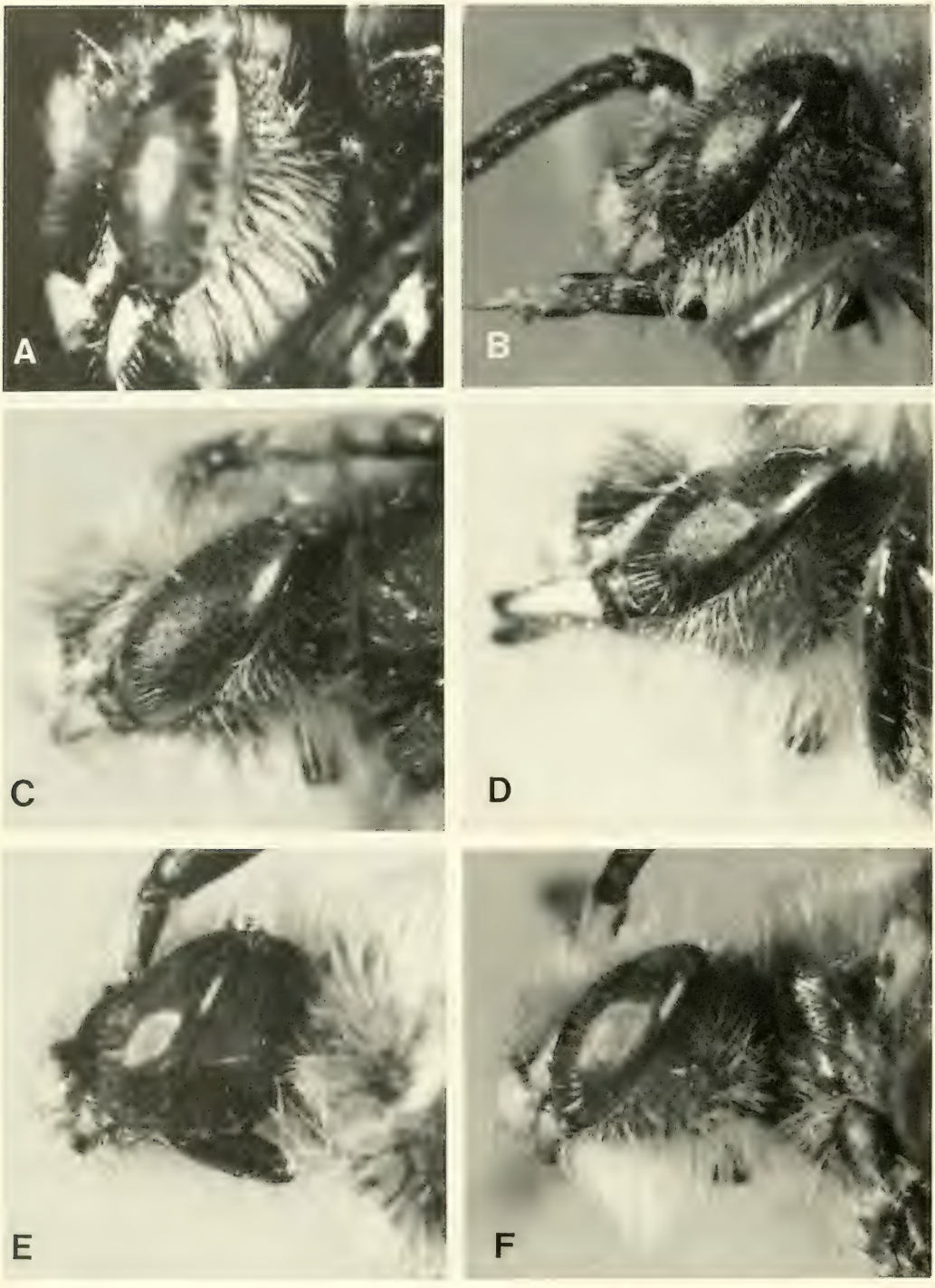

FIGURE 6. Male heads in side view. **A,** *Agapostemonoides hurdi;* **B,** *Dinagapostemon gigas,* lectotype; **C,** *D. goneus,* holotype; **D,** *D. mentor,* holotype; **E,** *D. mexicanus,* holotype; **F,** *D. orestes,* holotype.

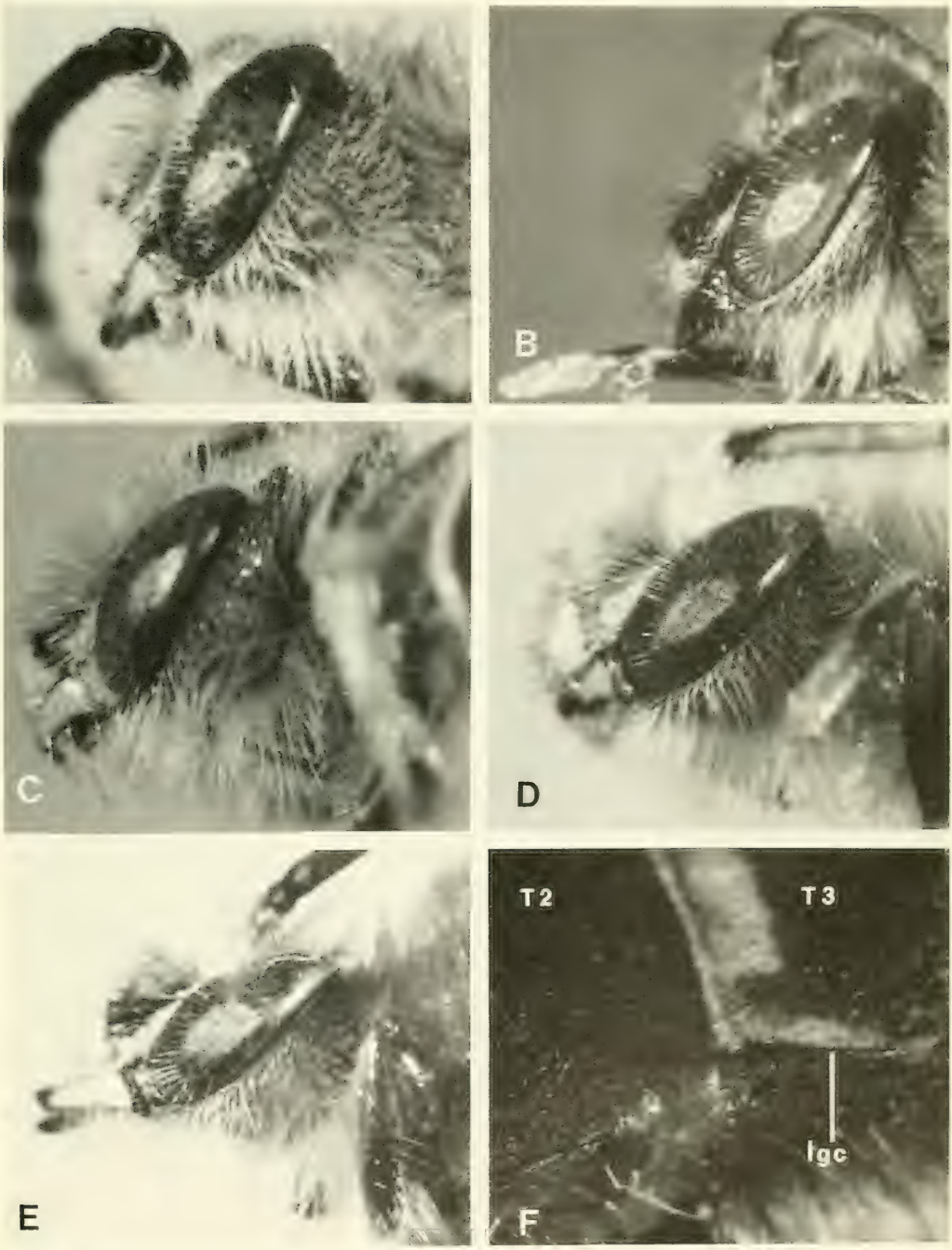

FIGURE 7. Male heads in side view (except F). **A,** *Dinagapostemon sicheli;* **B,** *D. uyacanus;* **C,** *Paragapostemon coelestinus;* **D,** *Rhinetula denticrus;* **E,** *Dinagapostemon mentor,* holotype; **F,** T2-T3 of *Rhinetula denticrus* male in lateral view, lgc, lateral gradular carina.

above antennal sockets, becoming coarser below; pubescence erect, dense and as long as scape medially (usually obscures median tooth below antennae), becoming short, feathery and appressed in paraocular area. (4) Vertex: Metallic; ocellar separation 0.6 od, lateral ocellus 2.1 od from eye, surface between eye and lateral ocellus distinctly concave, region posterior to ocelli rising only slightly before descending steeply to weak preoccipital carina; punctures minute, contiguous anteriorly and laterally, low widely spaced rugae behind ocelli; pubescence 1.0 od between ocelli, becoming longer posteriorly and shorter ventrally and laterally. (5) Gena: Metallic; area behind eye slightly concave and weakly striate, hypostomal carina 1.8 times as long as width of proboscidial fossa; pubescence 3.8 od posteromedially, becoming shorter anteriorly and laterally. (6) Malar area: Yellow with amber; 0.3 od between eye and mandibular base; glabrous. (7) Mandible: Yellow, distal 0.4 transparent reddish brown; without tooth or ridges; sparse golden hairs 3.7 od proximoventrally becoming shorter distally. (8) Antenna (Fig. 3f): Scape yellow ventrally and piceous dorsally, pedicel and dorsum of flagellum piceous, flagellum amber ventrally; flagellum twice as long as head width, first flagellomere half as long as other individual flagellomeres, flagellomeres 4-11 conspicuously sinuate (Fig. 3f). THORAX: Metallic green; pubescence yellow to amber dorsally, becoming creamy laterally, posteriorly and ventrally. (9) Pronotum: Lateral angle and posterior lobe rounded; minutely rugose; pubescence 2.5 od. (10) Mesoscutum: Uniformly covered with small, deep, contiguous punctures; pubescence 1.7 od, uniformly distributed. (11) Mesoscutellum: Punctures like those of mesoscutum but slightly coarser; pubescence like that of mesoscutum. (12) Metanotum: With rugae in addition to punctures like those of mesoscutum; pubescence longer than that of mesoscutum (3.8 od). (13) Mesepisternum: Fine rugae anteriorly becoming contiguous punctures posteriorly; pubescence 2.5 od. (14) Metepisternum: Contiguously punctate or finely rugose; pubescence like that of mesepisternum. (15) Propodeum: Moderately coarse to minute, contiguous punctures laterally and posteriorly, becoming coarsely rugose dorsomedially, with medial groove on lower 0.7 of posterior surface. (16) Wings: Pubescence about as long as diameter of adjacent wing veins distally, becoming 0.5 od proximally; veins and stigma dark brown, 10-13 hamuli on hind wing. (17) Tegula: Transparent amber, sometimes with metallic tints anteromedially; minutely punctate; pubescence dense, 0.8 od anteriorly, becoming shorter posteriorly. (18) Fore leg: Coxa metallic; pubescence moderately dense, 2.7 od. Trochanter brown to black; pubescence sparse, laterally 1.2 od. Femur brown with amber ventrally on distal 0.6; pubescence sparse, 1.0 od dorsally, shorter anteriorly and posteriorly and absent ventrally. Tibia amber, sometimes brown posteriorly; strigilis with transparent velum and amber malus, 3.8 od long; pubescence amber, 1.2 od posteriorly, becoming shorter dorsally and anteriorly, absent ventrally. Tarsus pale amber; distal tarsomeres together 0.8 as long as basitarsus; pubescence amber, 1.4 od dorsally, becoming shorter and more dense ventrally. (19) Middle leg: Similar to fore leg, tibial spur simple and 2.6 od long, tarsus piceous and exceptionally long and slender with basitarsus 1.1 times as long as tibia and 0.8 as long as tarsomeres 2-5 together. (20) Hind leg (Figs. 16a, 17f): Piceous, coxa with metallic tints; pubescence 2.1 od anteriorly and posteriorly, absent dorsally and ventrally. Trochanter (Fig. 14p) with large, thin ventral keel. Femur swollen, ventrally flattened area minutely ridged and terminating distally in a tooth followed by a concavity and second smaller tooth; pubescence 3.1 od proximodorsally, becoming shorter elsewhere and absent ventrally. Tibia with flat, minutely ridged ventral area and small tooth proximally which coincides with gap between femoral teeth, anterior spur 2.7 od long and posterior spur 5.5 od long (as long as fused tarsomeres 1 + 2); pubescence 0.6 od and scattered anteriorly, becoming dense, short and directed distad posteriorly. Tarsus with fused tarsomeres 1 + 2 1.4 times as long as tarsomeres 3-5 together; pubescence like that of other tarsi except for dense brush of distally directed bristles 1.1 od on posterior surface of basitarsus. METASOMA: (21) T1-T4 or T1-T5 each metallic anteriorly, becoming piceous posteriorly and often with transparent posterior margins, transparent brown ventrolaterally; T5-T7 or T6-T7 entirely piceous. T2-T4 with postgradular area depressed, concave and with distinct premarginal ridge 2.0 od from posterior margin. T7 with distinct pygidial plate (Fig. 14g). Punctures in postgradular areas like those of mesoscutum but smaller and shallower on premarginal ridge and separated by their diameters posterior to premarginal ridge. Pubescence cream-colored, 2.5 od anteriorly, becoming 1.0 od posteriorly. (22) Sterna (Fig. 10g): S1 with metallic tints anteriorly and amber to brown posteriorly; posterior margin concave medially; medial pubescence

sparse, 2.8 od. S2-S3 dark amber to brown; pubescence confined to visible apical half, sparse medially, moderately dense laterally, 0.9 od. S4 with posterior margin concave and thickened so as to appear to have two edges; dorsal edge (closest to S5) with 9-13 stout spines hooking abruptly ventrad (spines absent medially), ventral edge with fimbria of stiff, amber hairs curving gently dorsad, 0.6 od laterally to 1.7 od medially. S5 with posterior margin concave laterally as well as medially; broad V shaped band of amber hairs (1.7 od) directed posteriorly (V open posteriorly and extending anteriorly from posterolateral margin), tuft of 3-5 long (6.0 od), golden hairs on extreme lateral margin hooking anterolaterally and concealed basally by ventrolateral region of T5 (hairs most easily seen in dorsal view). S6 dark brown to amber, flat; pubescence sparse, short (0.5 od), and directed posteromedially. S7 and S8 (Fig. 18g). (23) Genitalia (Figs. 20e-g).

FEMALE (Figs. 3l, o, 8c, 9b, 12b). Agrees with description of male except, general coloration of head and thorax black with variable iridescence of metallic green to blue to purple varying with position in relation to light source, metasoma amber to dark brown and usually with metallic basally on T2-T4. Pubescence only 0.6-0.8 as long as in male. HEAD (Figs. 8c, 9b): Metallic coloration strongest in genal and interocular regions; pubescence cream-colored to amber. (1) Labrum: Dark amber to black;

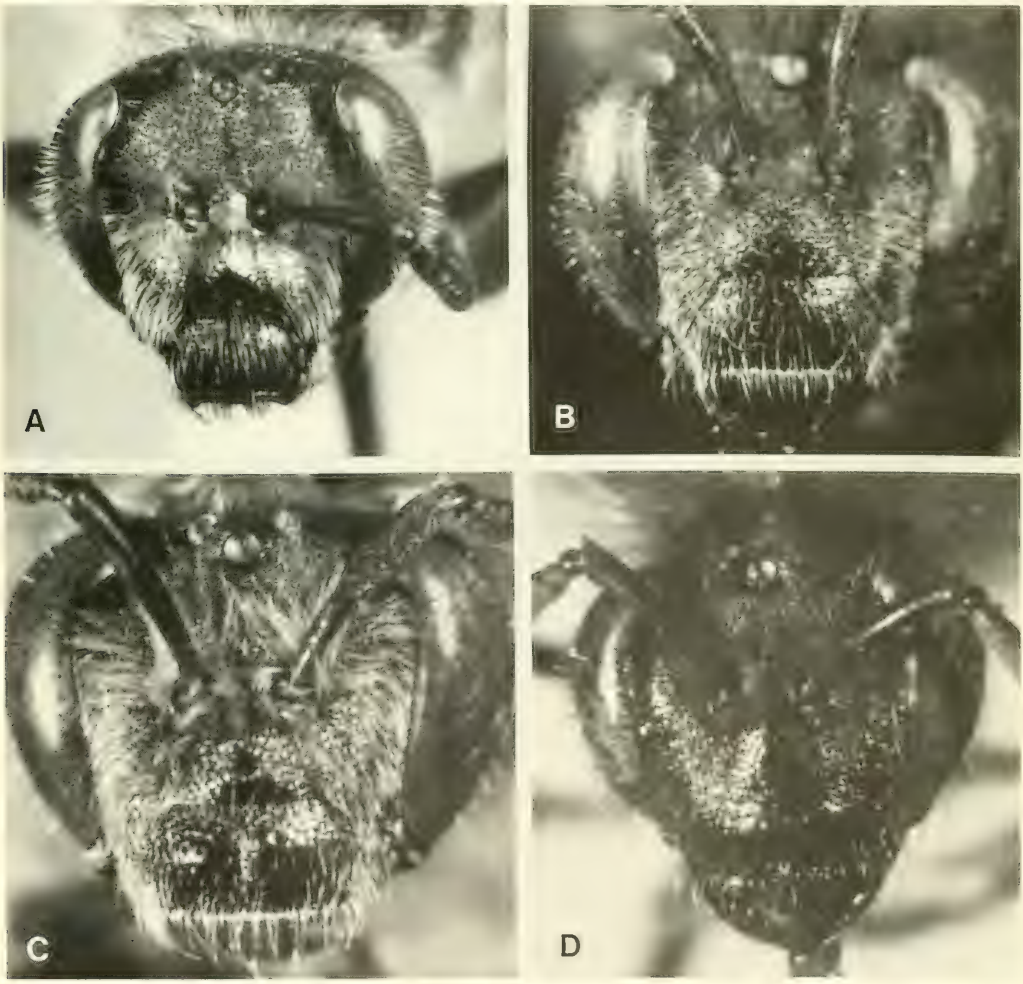

FIGURE 8. Female heads in front view. **A,** *Paragapostemon coelestinus;* **B,** *Rhinetula denticrus;* **C,** *Dinagapostemon sicheli;* **D,** *D. costaricensis.*

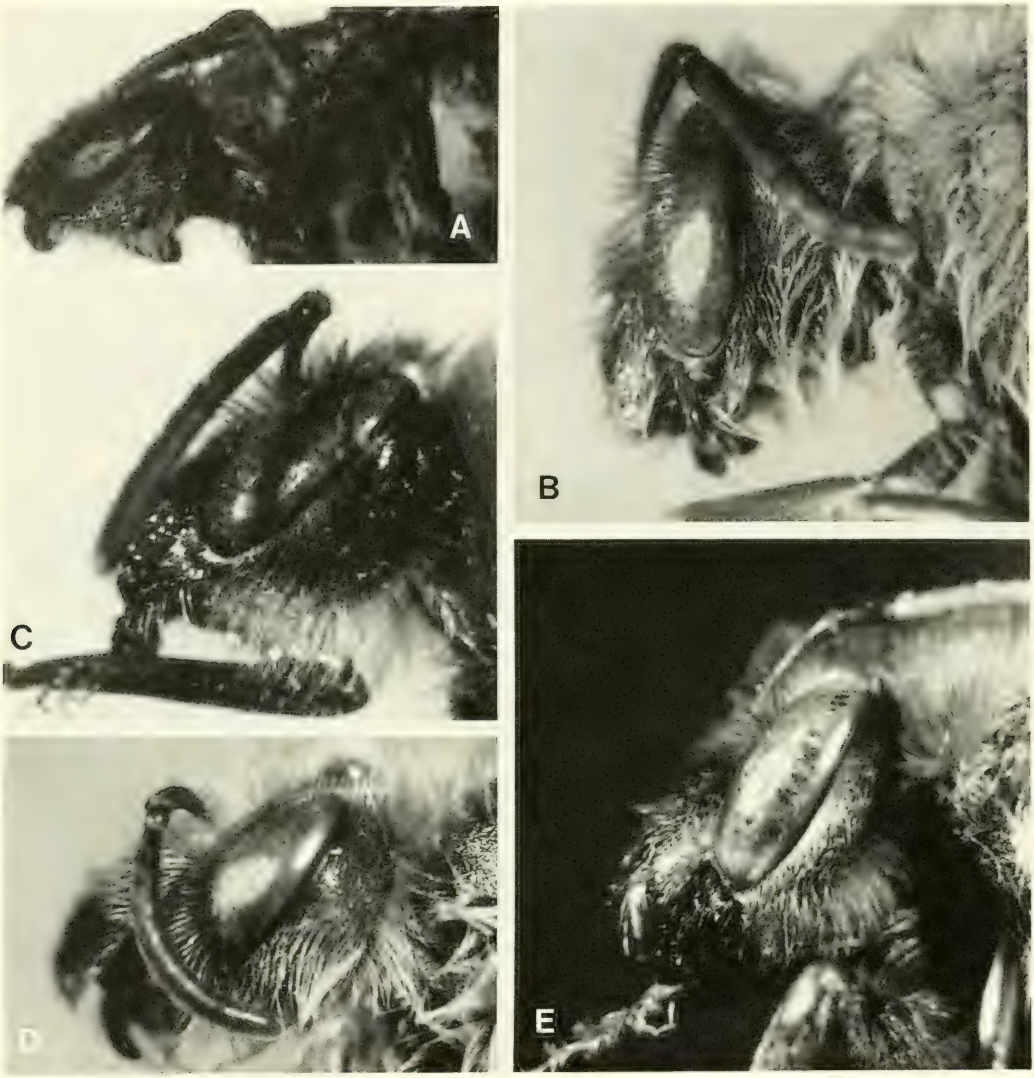

FIGURE 9. Female heads in side view. **A,** *Agapostemonoides hurdi;* **B,** *Dinagapostemon sicheli;* **C,** *D. costaricensis;* **D,** *Paragapostemon coelestinus;* **E,** *Rhinetula denticrus.*

basal area prominent, convex distally, concave proximally, irregularly rough and enclosed by flange; distal process with prominent distomedial keel, conspicuous lateral projection and marginal fimbria of amber, upturned bristles. (2) Clypeus: Coarsely punctate; fimbria of amber downturned bristles (3.0 od) between lateral teeth on distal margin. (3) Interocular area: Without medial tooth below antennal sockets; pubescence shorter than scape medially, not so dense and feathery as to obscure paraocular area. (5) Gena: Convex behind eye, finely striate. (7) Mandible: Amber to dark brown, with subapical tooth. (8) Antenna (Fig. 3o): Piceous with flagellum amber below. THORAX: Legs brown to black; pubescence like that of other female Halictinae; posterior spur of hind tibia with 6-8 teeth (Fig. 3l). METASOMA: (21) Terga (Fig. 12b): Pale yellowish amber to black, often with metallic tints basally on T2-T4; premarginal ridges and postgradular depressions less distinct than those of male; prepygidial fimbria of dense golden pubescence. (22) Sterna: Amber to black with moderately dense, erect pubescence 2.6 od.

***Dinagapostemon costaricensis* new species**

ETYMOLOGY: The name refers to its type locality in Costa Rica.

TYPES: Female holotype and one female paratype deposited in KU; other paratypes in LACM. Holotype from *COSTA RICA:* PUNTARENAS PROV.: Monteverde, 1500 m, January 1978, visiting *Ipomoea,* L. A. Real. Nine paratypes from same locality were collected 15-18 August 1976 by E. M. Fisher from flight trap with cineole bait.

DESCRIPTION: FEMALE (Figs. 8d, 9c, 12c-d). Similar to *D. sicheli,* differing as follows. Length about 12.5 mm. Head and thorax with slight metallic blue highlights, legs (except amber distitarsi) and metasoma dark, nonmetallic. T1-T6 varying from all black to amber (Figs.

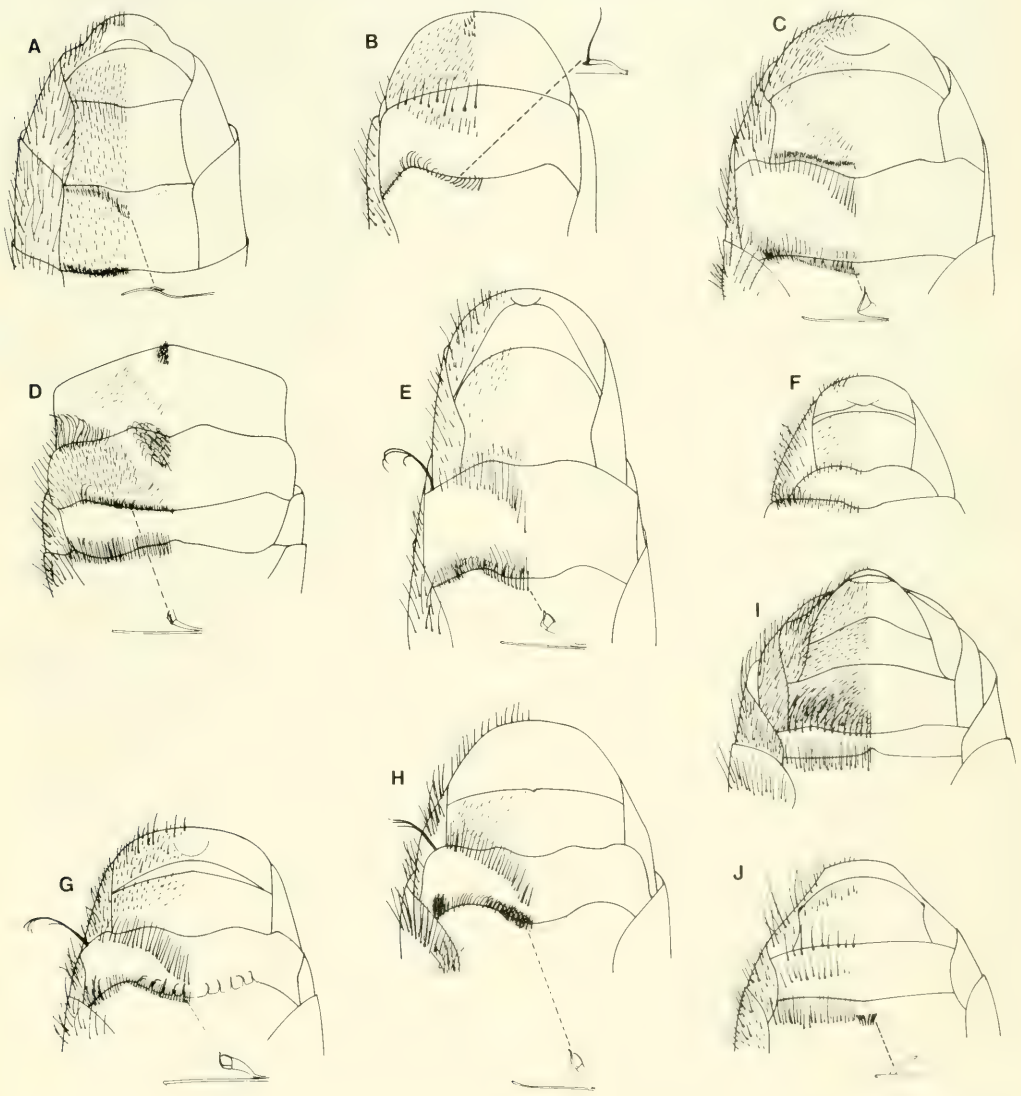

FIGURE 10. Apices of male metasomas in ventral view; A-E, G-H, J, also include side view of S4. **A,** *Agapostemonoides hurdi;* **B,** *Dinagapostemon gigas;* **C,** *D. goneus;* **D,** *D. mentor;* **E,** *D. mexicanus;* **F,** *D. orestes;* **G,** *D. sicheli;* **H,** *D. uyacanoides;* **I,** *Paragapostemon coelestinus;* **J,** *Rhinetula denticrus.*

12c-d). Hair dark fuscous, becoming paler on ventral and lower lateral surfaces of body. HEAD (Figs. 8d, 9c): Hair dark on head except pale on gena. THORAX: Hair fuscous except pale on ventral surface of fore tibia and fore tarsus; middle femur with basiventral brush amber; hind leg with hair on coxa, trochanter, and femoral corbicula pale, penicillus amber, ventral hair pale on tarsomeres 3-5. Posterior hind tibial spur with 7-11 teeth. METASOMA (Figs. 12c-d): Hair dark except terga with basal bands of pale hair (Fig. 12c) and ventral surface with hair all pale except apex of S6 with dark hair. Terga weakly shining, not dull like T1-T3 of *D. sicheli.*

Dinagapostemon gigas (Friese) new combination

Corynura gigas Friese 1911, pp. 454-455.
Rhinetula serraticornis Friese 1922, p. 584. New synonym.

TYPES: Both male types (ZMHU) are here designated lectotypes. The lectotype of *Corynura gigas* from "Columbia" [*sic*], Popayán [overwritten by "R. Casier"], 24-9-1908, Cali Cauca, Fassl leg., was presumably collected in Cauca Province. The lectotype of *Rhinetula serraticornis* is from Popayán, "Columbia" [*sic*], Lehman.

ADDITIONAL SPECIMENS: *COLOMBIA:* ANTIOQUIA PROV.: Rionegro, 2100 m, on *Eupatorium scabrum,* R. Añes, 3M, J. Cano, 4 M, 1 F; Caldas, G. Sierra, 1 M (all additional specimens at UNC except 1 M at KU).

DESCRIPTION: *MALE* (Figs. 3a, 4c, 6b, 10b, 12a, 14f, o, 15b, 17a, 18b, 19c-d). Similar to *D. sicheli,* differing as follows: Length 11-12 mm. Thorax metallic coppery to dark green becoming green laterally and ventrally, or green with blue to purple highlights laterally and posteriorly; metasoma pale amber anteriorly to black posteriorly (*R. serraticornis* type), or coppery green to green dorsally on T1 with apical and lateral margins black, basal metallic region becoming progressively narrower (often hidden by preceding tergum) on T2-T6, and absent on T7; sterna except apical margin of S6 sometimes amber (*C. gigas* lectotype). Legs dark, sometimes with amber on apical half of femur, anterior face of fore and mid tibiae, distitarsi, and posterior hind tibial and tarsal surfaces. HEAD (Figs. 4c, 6b): Pubescence creamy between eyes and on gena, becoming amber on vertex, eyes, clypeus, and labrum. (2) Clypeus: Yellow area smaller, occupying only elevated beveled area, and less flattened; pubescence simple, dark to light amber. (3) Interocular area: Metallic green with coppery tints; pubescence around antennae less dense. (4) Vertex: Metallic green with coppery tints; lateral ocellus 1.8 od from eye. (8) Antenna (Fig. 3a): Lacking yellow on scape; flagellum 2.3 times as long as head width. THORAX: Green to dark green with coppery tints, especially anteriorly on mesoscutum, lateral and posterior surfaces green, or green with blue to purple highlights. (11) Mesoscutellum: With shiny lateral areas where punctures are small and weak. (16) Wings: 9-10 hamuli on hind wing. (18) Fore leg: Tibia with malus 3.1 od long, tarsus with tarsomeres 2-5 together as long as basitarsus. (19) Middle leg: Similar to fore leg, tibial spur simple, 2.0 od long, basitarsus as long as tibia and almost as long as tarsomeres 2-5 together. (20) Hind leg (Figs. 15b, 17a): Coxa piceous with faint metallic coloration anteriorly and with large, distoventral, conical projection; trochanter piceous, lacking conspicuous projection or keel (Fig. 14o); femur all black to amber becoming piceous proximoventrally and on distoventral tooth, swollen with large flattened ventral area terminating in distal tooth followed by second much smaller tooth; tibia with anterior spur 2.5 od long and posterior spur long (8.0 od) and curved. METASOMA: (21) Terga (Fig. 12a): T1-T3 translucent amber, T4 amber with basal half piceous, T5-T7 piceous; pygidial plate (Fig. 14f). (22) Sterna (Fig. 10b): Anterior sterna amber, becoming piceous on posterior sterna. S4 with posterior margin broadly concave with row of about 38 stout spines 1.6 od, projecting ventrally and hooking posteriorly at apices. S7 and S8 (Fig. 18b). (23) Genitalia (Figs. 19c-d).

FEMALE: Metallic coloration dark green with coppery highlights. HEAD: Pubescence dark except pale on paraocular area and gena. THORAX: Pubescence fuscous except pale on margin of pronotal lobe, lateral surface of propodeum, hind coxa and trochanter; amber on metanotum, lateral margins of mesoscutum and scutellum, inner surfaces of fore tibia and tarsus, mesofemoral brush, mesotibial comb, hind femoral flocculus and inner surface of hind tarsus. METASOMA: Black with narrow basal bands of dark metallic green on T2-T4; pubescence dark except pale on basal half of T1 and narrow basal bands on T2-T4.

Dinagapostemon goneus new species

ETYMOLOGY: The name *goneus* means progenitor. This species is dedicated to the late

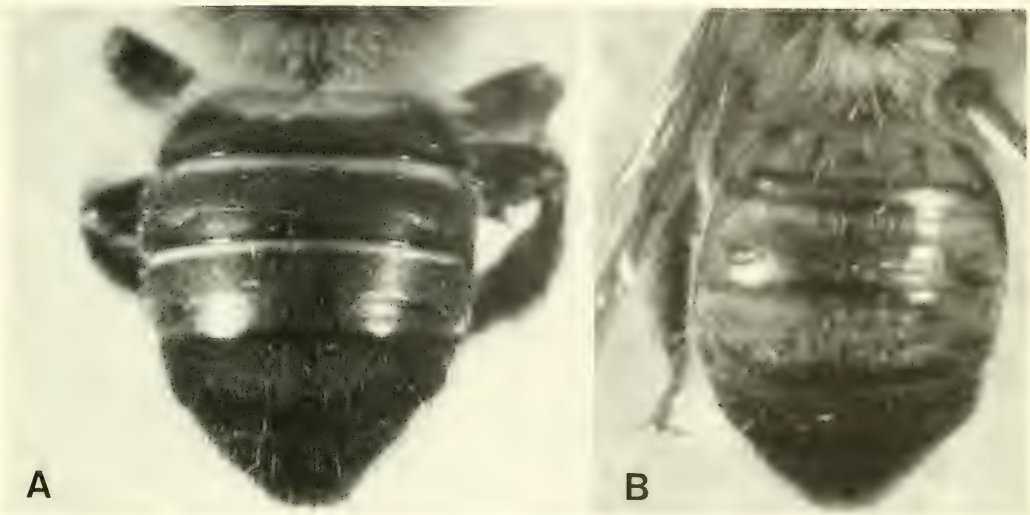

FIGURE 11. Male metasomas of *Rhinetula* dorsal view. A, Central American form with narrow basal amber band on T2 and T3; B, Peruvian form with broad amber bands on T1-T3.

H. Radclyffe Roberts, Jr., entomologist and father of the senior author.

TYPES: Male holotype (MCZ) and the male paratype (AMNH) are from *ECUADOR:* PICHINCHA PROV.: Tandapi, 1400 m (L. E. Peña). The holotype is labeled 15/20-VI-65, while the paratype is labeled 55 km SW of Quito on road from Machachi to Santo Domingo, VI-18-1965. Probably the two specimens of this southernmost species were collected together.

DESCRIPTION: *MALE* (Figs. 3h, 4b, 6c, 10c, 14b, k, 15a, 17b, 18c, 19e-f). Differs from *D. sicheli* as follows: Length 11-12 mm. Metallic purple laterally and ventrally on thorax in contrast to metallic green on thoracic dorsum. Pubescence brown on dorsal regions of head and thorax. HEAD (Figs. 4b, 6c): (8) Antenna (Fig. 3h): Scape entirely piceous. THORAX: (18) Fore leg: Tarsus brown to black. (20) Hind leg (Fig. 15a): Coxa with subapical ventral tooth; trochanter with blunt, apical, posteroventral tooth but lacking distinct ventral keel (Fig. 14k); tibia with posterior spur shorter than fused tarsomeres 1+2 together (Fig. 17b). METASOMA: (21) Terga: Pygidial plate slightly truncate (Fig. 14b). (22) Sterna (Figs. 10c): S4 with stout hooked spines medially as well as laterally on posterior margin. S5 lacking lateral tuft of long golden hairs. S7 and S8 (Fig. 18c). (23) Genitalia (Figs. 19e-f).

Dinagapostemon mentor new species

ETYMOLOGY: The name of *mentor* means loyal friend and wise counselor. We dedicate this species to Charles D. Michener, mentor in the scientific odysseys of the authors and many other students of Apoidea.

TYPE: Male holotype (KU) from *PANAMÁ:* CHIRIQUÍ PROV.: 6 km N of Bouquete (*sic*), Cerro Pate Macho, 1000 m, 25 Apr. 1981, D. Roubik. The locality is spelled "Boquete."

DESCRIPTION: *MALE* (Figs. 3b, 4d, 5c, 6d, 7e, 10d, 14c, l, 15d, 17c, 18d, 19g-h). Differing from *D. sicheli* as follows: Length 14.7 mm. Punctures slightly smaller and shallower. Pubescence brown dorsally on head and thorax, brown to black on metasomal terga and amber elsewhere. HEAD (Figs. 4d, 5c, 6d, 7e): Pubescence dark brown on metallic portion of clypeus and on interocular region above and below antennal sockets. (1) Labrum: Shorter, with longer hairs (1.0 od) forming marginal fimbria. (3) Interocular area: Lacking concavity below median ocellus; punctures below antennal sockets separated by several times their diameters. (8) Antenna (Fig. 3b): Piceous, without yellow ventrally on scape or amber ventrally on flagellum; flagellum 2.3 times as long as head width. THORAX: (18) Fore leg: Tarsus yellow; basitarsus as long as tarsomeres 2-5 together. (19) Middle leg: Extraordinarily long and slender (about 10 mm in length). Tarsus amber to yellow; basitarsus 1.2 times as long as tibia and 0.9 times as long as tarsomeres 2-5 together. (20) Hind leg (Figs. 15d, 17c): Trochanter with thick, bluntly pointed keel ventrally (Fig. 14l). Femur with distal teeth less acute and with

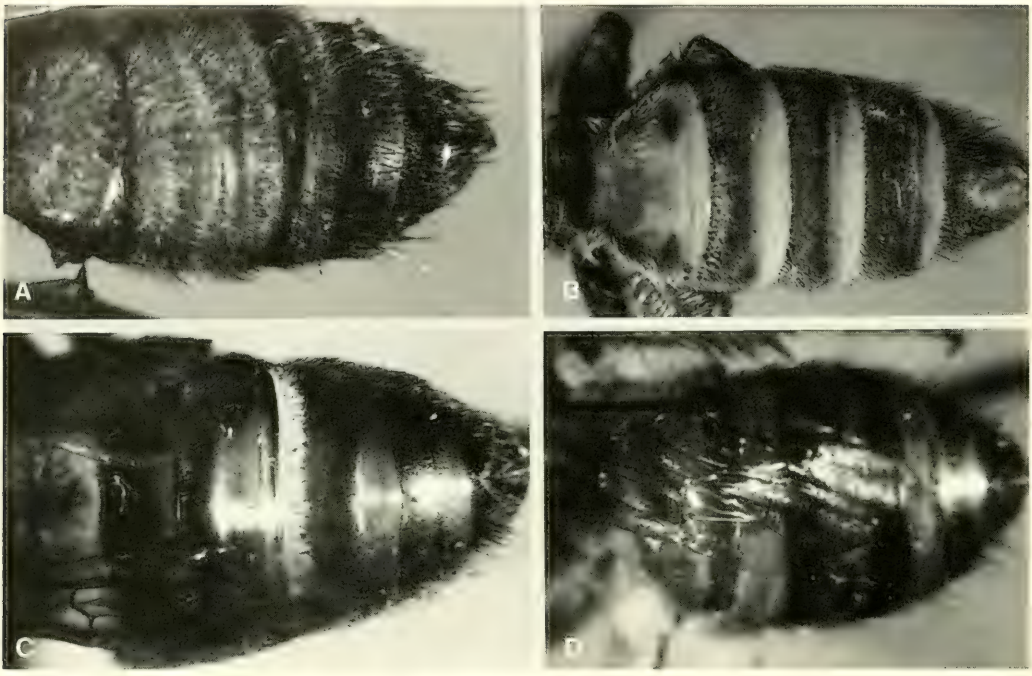

FIGURE 12. Metasomas of *Dinagapostemon* in dorsal view. **A,** Male *D. gigas,* lectotype; **B,** Female *D. sicheli;* **C,** Female *D. costaricensis,* dark form; **D,** Female *D. costaricensis,* amber form.

broad posteroproximal tooth. Tibia concave distoventrally and with broad, apical tooth anteroventrally; anterior spur 3.2 od long, posterior spur 3.8 od long and much shorter than fused tarsomeres 1 + 2 together. METASOMA: (21) Terga: Piceous and shiny with metallic blue-green basally on T1-T4 or T1-T5; pygidial plate large (Fig. 14c). (22) Sterna (Fig. 10d): Black with amber pubescence. S4 with posterior margin concave, bordered with minute brush of hairs ventrally, 2 spines projecting ventrally and hooking medially about 1.0 od lateral to center (Fig. 10d), 3-4 posterolateral spines projecting posteriorly and hooking medially. S5 with small, dense, V shaped brush of hairs centrally and lacking lateral tuft of long, golden hairs. S6 with low medial ridge clothed in short black bristles projecting posteriorly. S7 and S8 (Fig. 18d). (23) Genitalia (Figs. 19g-h).

Dinagapostemon mexicanus new species

ETYMOLOGY: This species is named for the nation of México in which it is found.

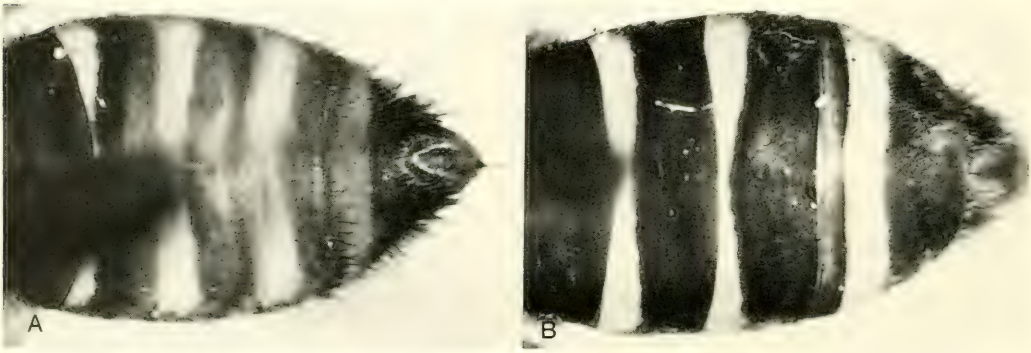

FIGURE 13. Metasomas of female *Agapostemonoides hurdi.* A, Amber form; B, Dark form.

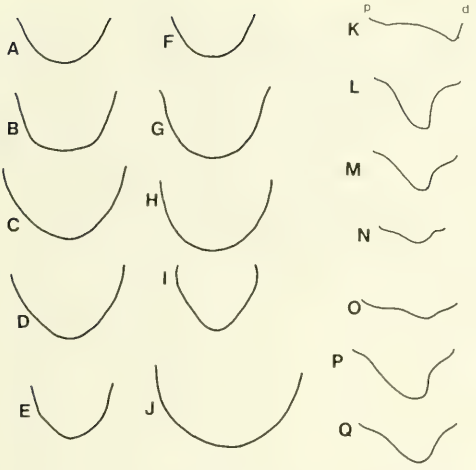

FIGURE 14. Outline of male pygidial plate in dorsal view (A-K); profile of ventral keels of male hind trochanters (L-S); p, proximad and d, distad. **A,** *Agapostemonoides hurdi;* **B,** *Dinagapostemon goneus;* **C,** *D. mentor;* **D,** *D. orestes;* **E,** *D. mexicanus;* **F,** *D. gigas;* **G,** *D. sicheli;* **H,** *D. uyacanus;* **I,** *Paragapostemon coelestinus;* **J,** *Rhinetula denticrus;* **K,** *Dinagapostemon goneus;* **L,** *D. mentor;* **M,** *D. mexicanus;* **N,** *D. orestes;* **O,** *D. gigas;* **P,** *D. sicheli;* **Q,** *D. uyacanus.*

TYPES: Male holotype (UNAM) and 2 male paratypes from *MÉXICO:* GUERRERO: Puente del Rey, 8 km S of El Paraiso, 29 Oct. 1983, R. Ayala. Additional paratypes from the same state: El Paraiso, 23 km "Carr., Pto. del Gallo" (Carretera, Puerto del Gallo), 20 Oct. 1983, R. Ayala, 6 M (UNAM), 2 M (KU); El Faisanal, 25 Oct. 1984, R. Ayala, 1 M (UNAM). MORELOS: 3 mi (4.8 km) N of Cuernavaca, 4 Apr. 1959, 7500 feet (2286 m), H. E. Evans and D. M. Anderson (CU).

DESCRIPTION: *MALE* (Figs. 3c, 4e, 6e, 10e, 14e, m, 15c, 17d, 18e, 20a-b). Differing from *D. sicheli* in its slightly smaller size (11 mm in length) and in characters mentioned below. HEAD (Figs. 4e, 6e): (8) Antenna (Fig. 3c): With flagellum less strongly sinuate. THORAX: Metallic green dorsally, becoming blue to bluish purple laterally. (20) Hind leg (Figs. 15c, 17d): Trochanter with ventral keel only 0.35 times as deep as long (Fig. 14m). METASOMA: (21) Terga: T7 with pygidial plate somewhat more pointed (Fig. 14e). (22) Sterna (Fig. 10e): S7 and S8 (Fig. 18e). (23) Genitalia (Figs. 20a- b): Distilateral angle of gonostylus with setae less than 0.3 as long as apical width of penis valve.

Dinagapostemon orestes new species

ETYMOLOGY: The name *orestes* means mountaineer, a reference to the montane habitat of this species.

TYPE: Unique male holotype (KU) from *COSTA RICA:* PUNTARENAS PROV.: 6 km S of San Vito, 8°42'N, 83°0'W, 25-28 Apr. 1967, D. F. Viers.

DESCRIPTION: *MALE* (Figs. 3d, 4f, 6f, 10f, 14d, n, 15f, 17e, 18f, 20c-d). Differing from *D. sicheli* in its slightly smaller size (11 mm in length) and in characters mentioned below. HEAD (Figs. 4f, 6f): Metallic green, becoming brassy on supraclypeal area and between subantennal sutures and bluish on gena; pubescence white, tinged with amber at vertex. (2) Clypeus: Yellow at midline occupying lower 0.9 clypeal length, metallic green above. (8) Antenna (Fig. 3d): Flagellum 2.5 times as long as head width. THORAX: Metallic green with brassy tints dorsally, metallic pinkish purple laterally and metallic blue-green ventrally; pubescence amber dorsally, creamy laterally and white below. (12) Metanotum: Rugose. (15) Propodeum: Nearly smooth laterally, becoming coarsely rugose medially. (18) Fore leg: Femur and tibia amber anteroventrally becoming brown posterodorsally, strigilis 3.9 od long. Tarsus brown. (19) Middle leg: Tibial spur 3.0 od long, tarsus not exceptionally long or slender, basitarsus 0.8 times as long as tibia and 0.9 times as long as tarsomeres 2-5 together. (20) Hind leg (Figs. 15f, 17e): With faint metallic tints on coxa and femur, otherwise dark amber to piceous. Coxa concave and shiny ventrally. Trochanter smooth and shiny ventrally, with weakly developed keel or tooth (Fig. 14n). Femur with ventral flattened area shorter than that of *D. sicheli.* Tibia with smooth ventral concavity bordered by large anteroventral distal ridge, anterior spur 2.9 od long, posterior spur 3.4 od long (shorter than basitarsus). Tarsus with fused tarsomeres 1 + 2 1.2 times as long as tarsomeres 3-5 together. METASOMA: (21) Terga: Dull brown to piceous with thin basal orange bands on T2-T3, with basal flecks of orange on T4; surfaces of terga without transverse ridges or concavities, punctation fine, continuous and uniform from base to posterior margin of each segment, pygidial plate large and projecting ventrad of S6 (Fig. 14d). (22) Sterna (Fig. 10f): S3 with low, shiny, Y-shaped ridge medially (Y opens posteriorly) and tuft of posteriorly directed hairs posterolaterally. S4 with lateral tuft of hooked hairs on posterolateral margin visible in dorsal view, becoming row of fine spines on posteromedial margin.

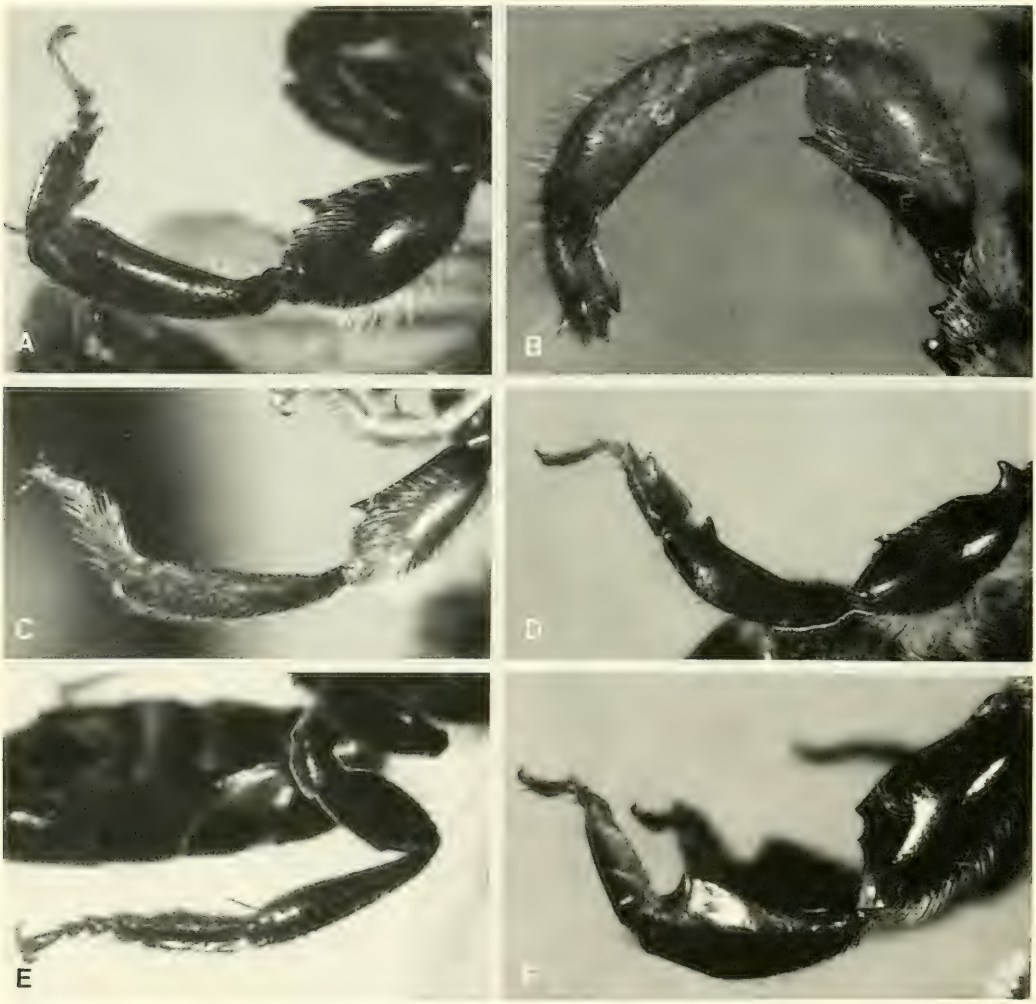

FIGURE 15. Male hind legs in anterior view, D and E slightly retouched to show structure. **A,** *Dinagapostemon goneus,* holotype; **B,** *D. gigas,* lectotype; **C,** *D. mexicanus,* holotype; **D,** *D. mentor,* holotype; **E,** *Agapostemonoides hurdi;* **F,** *Dinagapostemon orestes,* holotype.

S5 with group of short posteromedial, dark brown hairs. S7 and S8 (Fig. 18f). (23) Genitalia (Figs. 20c-d).

***Dinagapostemon uyacanoides* new species**

ETYMOLOGY: The name *uyacanoides* indicates this species' similarity to *D. uyacanus.*

TYPE: Unique male holotype (USNM) from *EL SALVADOR:* Monte Cristo, 7-9 May 1958, O. L. Cartwright.

DESCRIPTION: *MALE* (Figs. 10h, 17j, 18i). Extremely close to *D. uyacanus,* differing only in the following attributes. HEAD: Coppery highlights between bases of antennae and ocelli. THORAX: Coppery highlights on entire thorax, especially on longitudinal median area of mesoscutum, scutellum and metanotum. METASOMA: S7 without hair on median apical projection (Fig. 18i). S8 (Fig. 18i) with small acute apical and apicolateral lobes.

***Dinagapostemon uyacanus* (Cockerell) new combination**

Caenohalictus uyacanus Cockerell, 1949, p. 442.

TYPE: Male holotype (USNM) from *HONDURAS:* Top of Uyaca Peak, near Tegucigalpa, March 9, G. Cisneros.

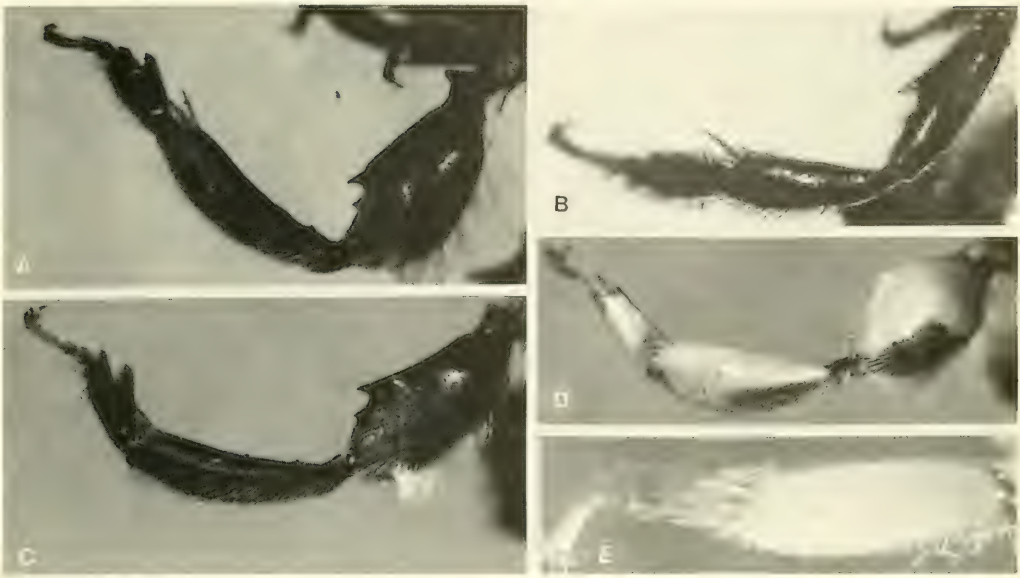

FIGURE 16. Male hind legs in anterior view (except E), B slightly retouched to show structure. **A,** *Dinagapostemon sicheli;* **B,** *Rhinetula denticrus;* **C,** *Dinagapostemon uyacanus;* **D, E,** *Paragapostemon coelestinus,* anterior and ventral views, respectively.

ADDITIONAL SPECIMENS: *GUATEMALA:* RETALHULEU PROV.: Helvetia, 1000 m, San Sebastian, 21-22 Apr. 1931, J. Bequaert (MCZ) 3 M.

DESCRIPTION: *MALE* (Figs. 3e, 5b, 7b, 14h, q, 16c, 17g, 18h, 20h- j). Similar to *D. sicheli,* differing as follows: THORAX: (20) Hind leg (Figs. 16c, 17g): Trochanter with ventral keel 0.35-0.40 times as deep as long (Fig. 14q). METASOMA: (22) Sterna: S7-S8 (Fig. 18h). (23) Genitalia (Figs. 20h-j): Penis valve with narrow dorsal crest (Fig. 20i).

HABRALICTUS Moure

Habralictus Moure, 1941, p. 59. Type species: *Habralictus flavopictus* Moure, 1941. Original designation.

DIAGNOSIS: Length 5-6 mm. Female head and thorax metallic green to brassy or dark with metallic green to brassy highlights, sometimes thorax with metallic highlights restricted to pronotum; clypeus usually with yellow spot; metasoma and legs black to dark brown, sometimes all dark, rarely all amber, usually with complete or medially interrupted basal yellow bands that are widest at lateral margins, bands sometimes reduced to small basolateral spots; eyes in male and female glabrous, rarely with hair, hair if present less than 0.5 od; male with mandible, labrum and apical half to two-thirds of clypeus bright yellow; pronotal lobe usually with yellow spot, legs with extensive yellow maculations; hind tarsomeres 1 and 2 articulated; metasoma very slender and elongate like that of *Neocorynura,* black to dark brown, sometimes all dark or with complete basal bands of yellow on T2-T4 similar to but less extensive than those of female, yellow usually restricted to small basolateral spots on T2-T3 or T2-T4; propodeum with dorsal surface half to two-thirds length of declivous surface which is not enclosed by carinae; metasomal terga without lateral gradular carinae; T1 of male microareolate below subspiracular carina; gonocoxite with striae fine to absent.

DISCUSSION: This genus is widespread, ranging from Guerrero, México, to southern Brasil. It contains 20 described species (Moure and Hurd, in press), three of which occur in Mesoamerica [*H. xanthinus* (Cockerell) in Panamá, *H. metallicus* (Friese) in Costa Rica and *H. tradux* (Vachal) in México]. Nesting biologies and sociality of *H. canaliculatus* Moure in Brasil (Michener and Lange, 1958) and *H. bimaculatus* Michener in Colombia (Michener, Breed and Bell, 1979) have been investigated. These species are solitary to communal or possibly quasisocial, with no castes; all females have

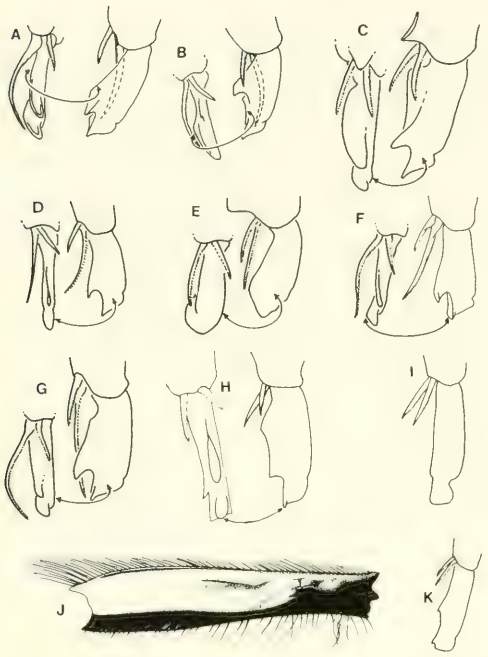

FIGURE 17. Male hind tarsomeres 1+2 showing spurs of hind tibiae (A-H); left drawing is ventral view and right drawing is anterior view (arrows point to identical points in the two views). Anterior view of hind tarsomeres 1+2 (I, K). Ventral view of hind tibia (J). **A,** *Dinagapostemon gigas;* **B,** *D. goneus;* **C,** *D. mentor;* **D,** *D. mexicanus;* **E,** *D. orestes;* **F,** *D. sicheli;* **G,** *D. uyacanus;* **H,** *Paragapostemon coelestinus;* **I,** *Rhinetula denticrus;* **J,** *Dinagapostemon uyacanoides;* **K,** *Agapostemonoides hurdi.*

enlarged ovaries. They nest aggregatively in earthern banks and probably are all polylectic for they possess unspecialized scopae.

PARAGAPOSTEMON Vachal

Halictus (Paragapostemon) Vachal, 1903, pp. 89, 96. Type species: *Halictus (Paragapostemon) podager* Vachal 1903 (=*Nomia coelestina* Westwood, 1875), designated by Cockerell, 1905, p. 354.

DIAGNOSIS: About 9-12 mm in length; metallic green to blue; malar space about half as long as wide; hair on eye more than 1.0 od; flagellomere 1 distinctly longer than flagellomere 2 in female; legs of male mostly yellow with some green maculae, hind leg swollen, with femoral and basitarsal teeth, hind tarsomeres 1 and 2 fused; propodeum almost entirely declivous with little dorsal surface; T2-T4 with well developed lateral gradular carinae; lateral area below subspiracular carina on T1 of male microareolate; gonocoxite without striae; S8 of male distinctly trilobed at apex, spiculum present.

DISCUSSION: *Paragapostemon* is the sister group to *Dinagapostemon* (Fig. 2).

Paragapostemon coelestinus (Westwood)

Nomia coelestina Westwood, 1875, p. 220. Male holotype (OX).

Nomia caelestina; Dalla Torre, 1896, p. 164 (unnecessary emendation).

Agapostemon bruneri Crawford, 1901, p. 160. Male lectotype (NU). New synonym.

Nomia cillaba Cameron, 1902, p. 376. Male lectotype (BMNH).

Halictus (Paragapostemon) podager Vachal, 1903, pp. 89, 96. Male lectotype (MNHN). New synonym.

TYPES: Male holotype of *Nomia coelestina* (dark metallic blue form) has no legible locality data but Westwood (1875) records it from México. The male lectotype of *Agapostemon bruneri* (bright metallic green form), here designated, is labeled as from Tlalpam, México, L. Bruner. "Tlalpam" is probably a misspelling of Tlalpan, D. F. The male lectotype of *Nomia cillaba* (bright metallic green form; B. M. Type No. 17.a.1220a), here designated, is the same specimen that J. S. Moure labeled as a lectotype in 1957; to our knowledge he did not publish this designation. It is labeled New Mexico, P. Cameron. Cameron (1902) records the species from the Santa Fé District, New Mexico, but the locality is incorrect (Hurd and Linsley, 1976, pp. 46-47). The male lectotype of *Halictus podager* (bright metallic green form), here designated, is labeled "Meztill, États-Unis, 1867, O. Sichel." The meaning of United States on the label is unknown and the word Meztill might mean México or a village in México since this is strictly a Mexican species.

DISTRIBUTION: Mexican plateau and as far south as Oaxaca between 1800 m and 2700 m from July through November. Blue form prevalent at higher altitudes (2340-2682 m) and green form somewhat lower (1890-2590 m).

ADDITIONAL SPECIMENS: *MÉXICO:* COLIMA: Colima, 2 M (UNAM). DISTRITO FEDERAL: Colonia Lindavista 2 M (UNAM); México City, 2340 m, 8 M, 2 F (CU), 3 M (LACM), 1 M (MSU), 1 M (REM), 1 F (KU); Pedregal, 11 M (KU). DURANGO: 6.4 km NE of El Salto,

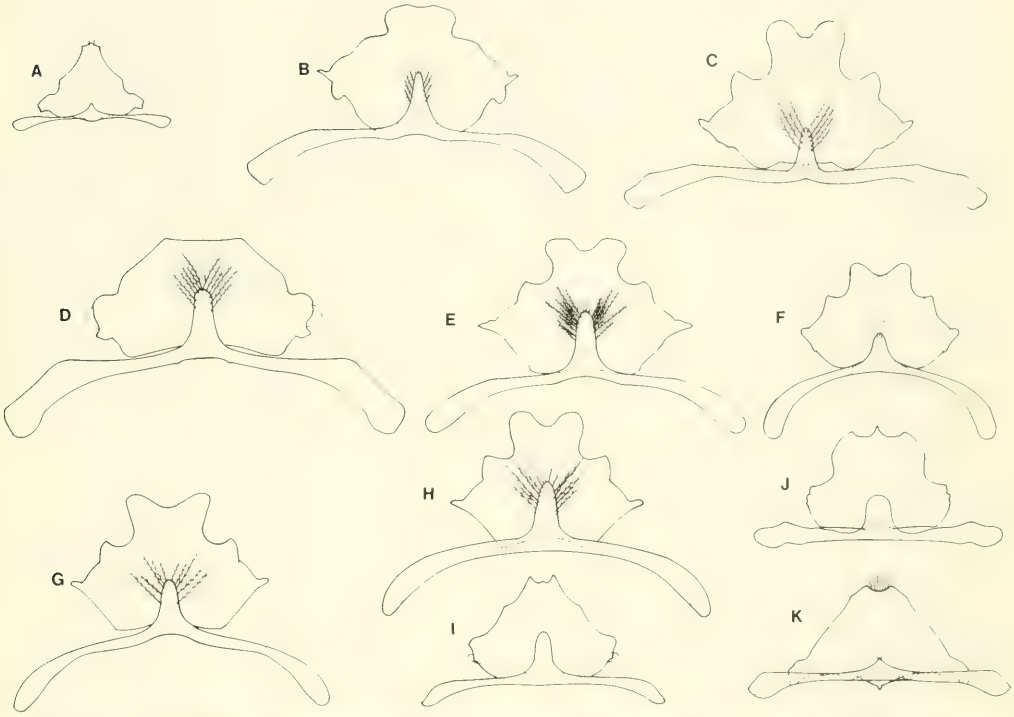

FIGURE 18. Male S7 and S8. **A,** *Agapostemonoides hurdi;* **B,** *Dinagapostemon gigas;* **C,** *D. goneus;* **D,** *D. mentor;* **E,** *D. mexicanus;* **F,** *D. orestes;* **G,** *D. sicheli;* **H,** *D. uyacanus;* **I,** *D. uyacanoides;* **J,** *Paragapostemon coelestinus;* **K,** *Rhinetula denticrus.*

2591 m, 2 M (AMNH). GUANAJUATO: Roigue, 1 M (LACM). GUERRERO: 8 km S, 3.2 km E of Chilpancingo, 1 M (REM). HIDALGO: 8.1 km W of Pachuca, 2408 m, 4 M, 1 F (REM); 17.7 km E of Pachuca, 2454 m, 7 M (REM); Tepeapulco, 2 M (UTAH); 9.7 km E of Tulancingo, 2103 m, 9 M (KU); 11.3 km S of Tulancingo, 2286 m, 58 M (KU); Zimapán, 1951 m, 1 M (OSU). JALISCO: Mazamitla, 1 M (KU); 6.4 km W of Mazamitla, 2073 m, 1 M (AMNH); 11.3 km S of Mazamitla, 1 F (KU); Tepatitlán, 1 M (UTAH). MÉXICO: Amecameca, 2682 m, 1 M (CU), 1 M (MSU); Atlacomulco, 2591-2682 m, 9 M, 2 F (KU), 5 M (LACM), 1 M (MSU), 2 M (OSU); Chapingo, 5 M (KU), 1 M (UTAH); 86 km E of Tlalpan, 2 M (KU); 34 km W of Toluca, 2591 m, 1 M (MCZ); 38.9 km NW of Toluca, 4 M (KU). MICHOACAN: Morelia, 4 M (KU, LACM, MSU, and OSU); 74 km W of Morelia, 1996 m, 1 M (OSU); Lago Patzcuaro, 2073 m, 1 M (OSU); Tancítaro, 2100 m, 1 M on *Ipomoea,* 4 M, 2 F (UNAM); 27.4 km W of Tuxpan, 2255 m, 1 F (OSU); 41.8 km W of Tuxpan, 2423 m, 1 M, 2 F (OSU). MORELOS: Cuernavaca, 1 M. NUEVO LEÓN: 85.3 km S of Saltillo, 1 M (KU). OAXACA: Huajuapan de León, 1 M (KU); Monte Albán, 1 M (KU); 11.4 km N of Yanhuitlán, 2408 m, 1 M (LACM). PUEBLA: 59.6 km N of San Hipalito, 6 M (UCB). SAN LUIS POTOSÍ: El Aguila, 1 F (UCB); 22.5 km E of San Luis Potosí, 1890 m, 1 M (OSU); 24.1 km E of San Luis Potosí, 1981 m, 1 M (OSU). TLAXCALA: 16.1 km N of Apizaco, 2377 m, 29 M (REM). VERACRUZ: Banderilla, 1 M (LACM); Perote, 2590-2743 m, 1 M (KU); 6.4 km S of Perote, 55 M (UCB). ZACATECAS: Río Grande, 2 M (UTAH); Saín Alto, 1 M (UTAH).

HABITS: There are only two flower records for females of this species. One was collected on squash *(Cucurbita)* and two on cactus *(Opuntia).* That both these plants have extremely large pollen grains may be of some significance. Males have been collected sleeping in flowers of prickly poppy *(Argemone)* by RBR. They have also been collected at *Brickellia, Flourensia, Ipomoea, Lopezia racemosa,* and *Sphaeralcea.* That we have seen 254 males and only 11 females in collections leads us to suspect that females are

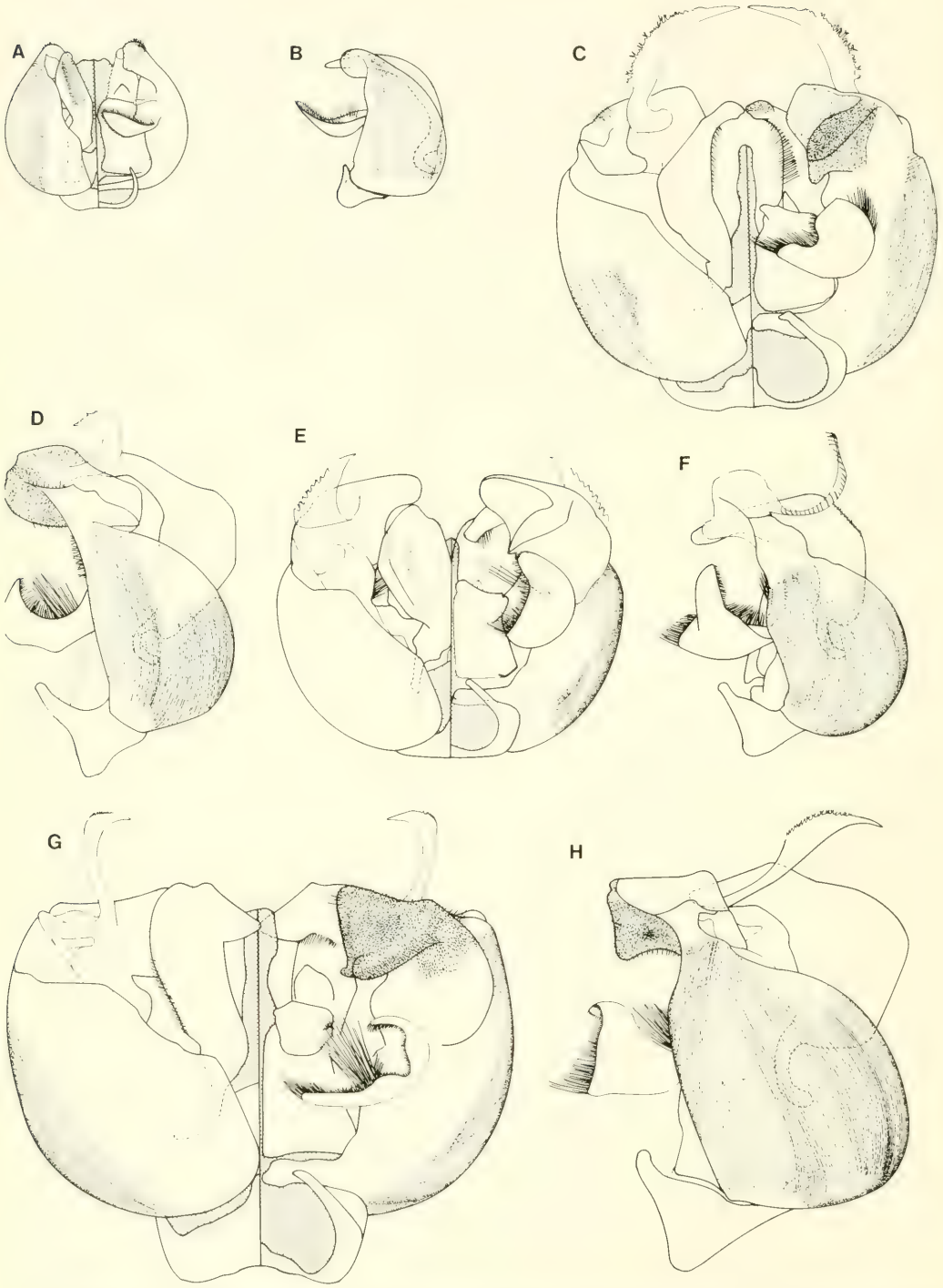

FIGURE 19. Male genitalia in dorsoventral and side views; left half is dorsal, right half is ventral in divided drawings. All drawn to same scale. **A-B,** *Agapostemonoides hurdi;* **C-D,** *Dinagapostemon gigas;* **E-F,** *D. goneus;* **G-H,** *D. mentor.*

either matinal and/or crepuscular or are oligolectic on a rarely encountered host.

DESCRIPTION: *MALE* (Figs. 3g, 5e, 7c, 10i, 14i, 16d-e, 17h, 18j, 20k-l). General color bright metallic green or purplish blue. Length 9-12 mm. HEAD (Figs. 5e, 7c): Pubescence cream-colored, pale amber on eyes. (1) Labrum: Yellow; central region with small punctures separated by 2-3 times their diameter; distal margin with fimbria of golden hairs 0.8 od. (2) Clypeus: With yellow at midline occupying lower 0.4 clypeal length, metallic above; hairs 1.0 od and separated by 2-3 times width of basal punctures. (3) Interocular area: Metallic except for piceous paraocular strip 1.0 od wide; surface flat above antennal sockets and with distinct supraclypeal bulge below sockets; punctures minute and contiguous above antennal sockets, becoming coarser below; pubescence erect, nearly as long as scape medially, becoming short laterally and ventrally. (4) Vertex: Metallic; ocellar separation 0.8 od, lateral ocellus 2.1 od from eye, surface between eye and lateral ocellus concave, region posterior to ocelli sloping dorsally before abruptly turning ventrally (not carinate); minute contiguous punctures around ocelli, becoming coarser posteriorly; pubescence 2.4 od. (5) Gena: Metallic; area behind eye concave; weakly striate, hypostomal carinae 2.5 times as long as width of proboscidial fossa; pubescence 2.0 od posteromedially, becoming shorter anteriorly and laterally. (6) Malar area: Yellow; 1.0 od between eye and mandibular base; pubescence sparse, very short and directed ventrally. (7) Mandible: Yellow with apical 0.25-0.35 transparent, reddish brown; without tooth or ridges; sparse, golden hairs 2.4 od proximoventrally, becoming shorter distally. (8) Antenna (Fig. 3g): Scape, pedicel and dorsum of flagellum piceous (scape sometimes marked with yellow), flagellum amber ventrally. THORAX: bright metallic green or purplish blue; pubescence amber dorsally, cream-colored laterally and posteriorly, becoming white ventrally. (9) Pronotum: Lateral angle and posterior lobe rounded; minute, subcontiguous punctures laterally, becoming slightly coarser dorsomedially; pubescence fairly dense, 2.1 od. (10) Mesoscutum: Uniformly covered with small, deep, contiguous punctures; pubescence 1.5 od, uniformly distributed. (11) Mesoscutellum: Punctures like those on mesoscutum but slightly coarser; pubescence like that of mesoscutum. (12) Metanotum: Punctures coarser than those of mesoscutellum; pubescence like that of mesoscutellum. (13) Mesepisternum: Coarsely punctate to finely rugose; pubescence 2.4 od. (14) Metepisternum: Finely, horizontally rugose; pubescence 2.8 od. (15) Propodeum: Covered with small, contiguous punctures and with broad, deep, posteromedial groove terminating dorsally in short, transverse ridge; pubescence 2.6 od laterally, becoming 1.6 od posteromedially. (16) Wings: Clothed with minute brown hairs about as long as diameter of adjacent veins distally, becoming longer (0.5 od) proximally, veins and stigma dark brown, 8-10 hamuli on hind wing. (17) Tegula: Transparent brown with anterior third metallic; minute, widely scattered punctures; glabrous posterolaterally but with dense hairs anteriorly 1.5 od. (18) Fore leg: Coxa metallic laterally, becoming piceous medially; pubescence 2.2 od. Trochanter piceous dorsally and yellow ventrally; pubescence dorsolateral, 1.5 od distally, becoming 0.5 od proximally. Femur yellow with dorsal region piceous and metallic; pubescence dorsal, 1.8 od. Tibia yellow with brown to black longitudinal stripe posteriorly; strigilis with transparent velum and yellow malus 2.8 od long. Tarsus yellow; basitarsus about as long as tarsomeres 2-5 together; covered with golden bristles 0.5-1.2 od. (19) Middle leg: Similar to fore leg. Tibial spur 2.2 od long and basitarsus 0.75 as long as tibia. (20) Hind leg (Figs. 16d-e, 17h): Coxa metallic with yellow ventrally; pubescence 2.3 od anteriorly, becoming shorter posteriorly and absent dorsally. Trochanter piceous with yellow ventrally; pubescence 1.3 od anteriorly and posteriorly but absent dorsally and ventrally. Femur yellow with piceous markings, becoming metallic above; swollen but flattened posteriorly and with sharp edge on distal half of posteroventral margin; pubescence 2.8 od dorsally, shorter anteriorly, absent ventrally and posterocentrally. Tibia with anterior spur 2.0 od long and posterior spur 2.7 od long; pubescence 2.8 od and scattered anteriorly, becoming dense, short and directed distad posteriorly. Tarsus with fused tarsomeres 1 + 2 1.5 times as long as tarsomeres 3-5 together; pubescence like that of other tarsi except for dense brush of distally directed bristles 0.9 od on posterior surface of basitarsus. METASOMA: (21) Terga: Bright metallic green or purplish blue with piceous premarginal ridge and transparent posterior margin, ventrolateral region transparent brown, pygidial plate yellow to piceous; T2-T4 with gradulus extending posterolaterally so as to form small lateral flanges, pregradulus raised but postgradular area depressed and concave; T1-T4 with distinct premarginal ridge 2.0 od from posterior tergal margin; T7 with distinct subtriangular pygidial plate (Fig. 14i)

and medial notch in ventral (distal) margin; punctures in postgradular area like those of mesoscutum but smaller and shallower on premarginal ridge; pubescence cream-colored, 2.0 od anteriorly, becoming 1.1 od posteriorly. (22) Sterna (Fig. 10i): S1 metallic anteriorly and transparent amber posteriorly; posterior margin concave medially; medial pubescence sparse, 2.0 od. S2-S3 pale amber to brown with posterior margin transparent; scattered pubescence 1.5 od and separated by 0.6 od. S4 pale amber to black with faint metallic hue; posterior margin broadly concave with gradulus bowed rearward medially and separated from distal margin by 1.0 od, surface concave distal to gradulus but becoming convex posterolaterally; pubescence moderately sparse, hairs fringing gradulus 0.5 od, hairs up to 1.6 od posterolaterally, 6-8 submarginal, stout, hooked spines laterally 1.6 od with shorter and less conspicuous spines medially. S5 brown to black proximally, metallic laterally, amber to brown distomedially; distal margin convex, surface slightly concave medially, becoming convex laterally; pubescence directed posteromedially, 1.2 od posterolaterally, becoming shorter anteromedially. S6 brown to black anteriorly and laterally, becoming amber to yellow posteromedially, surface slightly concave medially and convex laterally; pubescence in central region appressed, directed medially and 2.0 od, becoming erect and 1.3 od laterally. S7 and S8 (Fig. 18j). (23) Genitalia (Figs. 20k-l).

FEMALE (Figs. 3m, p, 8a, 9d). Agrees with description of male except lacking yellow markings, pubescence only 0.4-0.8 times as long as that of male, and the following. HEAD (Figs. 8a, 9d): (1) Labrum: Dark amber; basal area prominent, irregularly rough and enclosed by flange; distal process with prominent distomedial keel and marginal fimbria of amber upturned bristles. (2) Clypeus: Fimbria of amber downturned bristles (2.8 od) between lateral teeth on distal margin. (4) Vertex: Area between eyes and ocelli not as concave as in male, region behind ocelli more gently rounded than in male. (5) Gena: Area behind eye not concave. (7) Mandible: Amber to dark brown, with subapical tooth. (8) Antenna (Fig. 3p). THORAX: (16) Wings: Hamuli 8-14. (18-20) Legs: Brown, coxae metallic dorsally; pubescence typical of female Halictinae; posterior spur of hind tibia with 7-8 teeth (Fig. 3m). METASOMA: (21) Terga: Premarginal ridges and postgradular depressions less distinct than those of male; prepygidial fimbria golden. (22) Sterna: Amber to black except S1 metallic anteriorly; pubescence moderately dense, erect, 3.2 od.

RHINETULA Friese

Rhinetula Friese, 1912, p. 185. Type species: *Rhinetula denticrus* Friese, 1922, designated by Sandhouse, 1943, p. 596.

DIAGNOSIS: Brown with green to blue metallic hue on upper half of face and thorax, T2-T4 with basal amber band (Peruvian populations with terga mostly amber); metasoma nonmetallic; malar space linear; hair on eye about 1.0 od; legs of male dark, hind leg with two femoral teeth (median one long and acute, subapical one obtuse and small) hind tarsomeres 1 and 2 fused; propodeum entirely declivous, propodeal triangle weakly defined; T2-T4 with well developed lateral gradular carinae, lateral area below subspiracular carina on T1 of male mirror-like without microsculpturing, metasoma of male similar in shape to that of female, a little longer than wide, S4 of male with 5-8 suberect, anteriorly-directed, mediosubapical spines; gonocoxite with striae, gonostylus with small simple membranous appendage; S8 of male apically narrowed and bilobed.

DISCUSSION: *Rhinetula* is the only agapostemonine in which the male metasoma is similar in shape to that of the female, that is, only a little longer than wide. In addition, the lateral area below the subspiracular carina on T1 of the male is mirror-like without microsculpturing. All other male agapostemonines have narrow, elongate metasomas, and lateral areas below subspiracular carinae that are microareolate on T1. Furthermore, all other male agapostemonines have long antennae reaching posteriorly past the propodeal triangle; in *Rhinetula* they are short, like those of the female, not reaching the mesoscutellum.

Rhinetula denticrus Friese

Rhinetula denticrus Friese, 1922, p. 583. Male lectotype (ZMHU).

Rhinetula rufiventris Friese, 1922, p. 584. Male holotype (ZMHU). New synonym.

TYPES: Male lectotype of *Rhinetula denticrus,* here designated, is from *COSTA RICA:* San Carlos, 1902. It is likely that the San Carlos (9°14'N, 83°35'W), near the border of the Provinces of San José and Puntarenas, is the type locality. Male holotype of *Rhinetula rufiventris* is from *BOLIVIA:* Tarata, 1900.

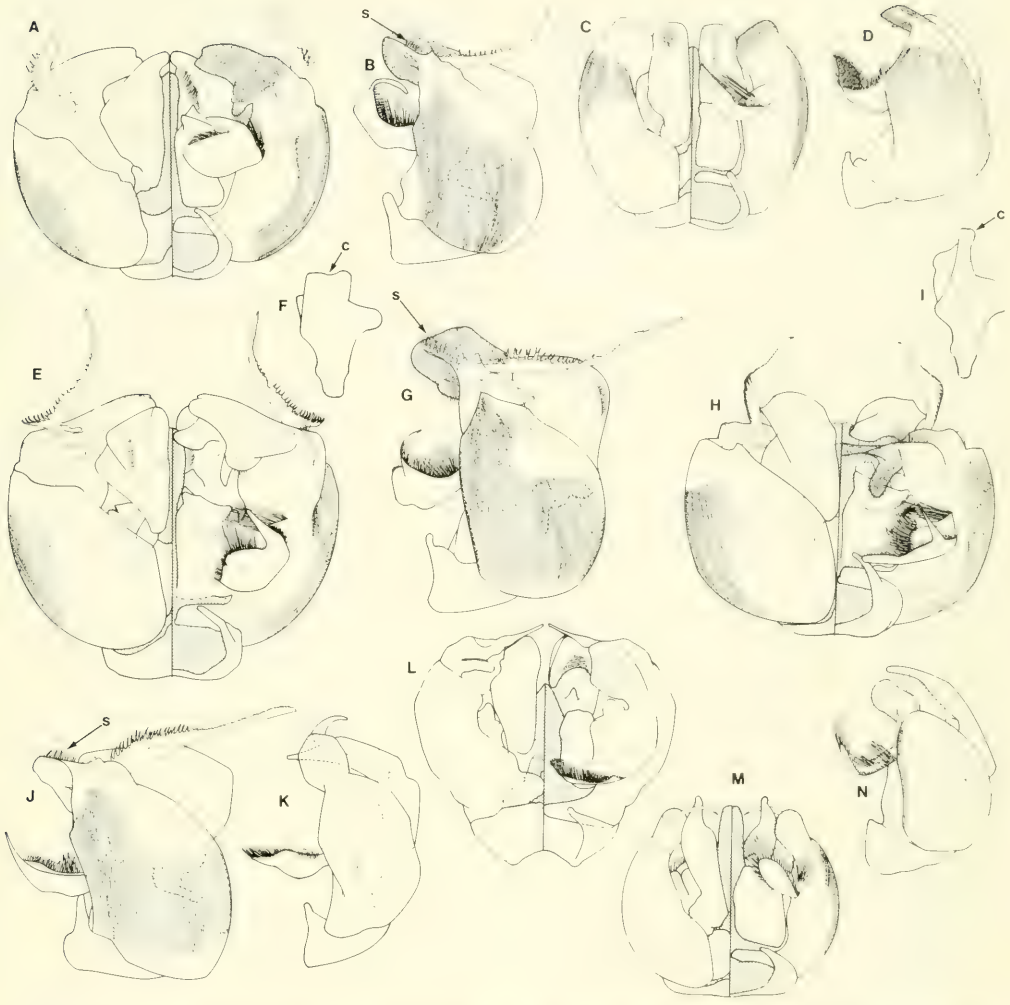

FIGURE 20. Male genitalia in dorsoventral and side views unless otherwise stated; left half is dorsal, right half is ventral in divided drawings. All drawn to same scale. c, crest of penis valve, s, setae. **A-B,** *Dinagapostemon mexicanus;* **C-D,** *D. orestes;* **E-G,** *D. sicheli* (F, dorsoapical view of apex of penis valve); **H-J,** *D. uyacanus* (I dorsoapical view of apex of penis valve); **K-L,** *Paragapostemon coelestinus;* **M-N,** *Rhinetula denticrus.*

DISTRIBUTION: This species is found in wet forests from Honduras to Bolivia.

ADDITIONAL SPECIMENS: *COSTA RICA:* CARTAGO PROV.: Turrialba, 12 Aug. 1964, R. B. and M. G. Roberts, 1 M (REM). HEREDIA PROV.: Finca La Selva, 152 m, 25 Apr. 1979, on *Cassia,* 0815-0915 h, D. R. Perry, 1 M (LACM); Puerto Viejo, 14 Mar. 1976, D. H. Janzen, 1 M (KU). PUNTARENAS PROV.: Golfito, 11 Jul. 1957, A. Menke, 1 M (LACM). SAN JOSÉ PROV.: San José, 21 Feb. 1962, A. Wille, 1 M (KU). *HONDURAS:* ATLÁNTIDA PROV.: Tela, Lancetilla, 6 Apr. 1923, T. H. Hubbell, 1 M (KU). *PANAMA:* COLÓN PROV.: Barro Colorado Island, 15 Mar.-4 May 1963, C. W. and M. E. Rettenmeyer, 18 M, 17 F (KU), 14 Jul. 1965, E. M. Fisher, 1 M (RWB), 24 Jul. 1963, M. E. Irwin and D. Q. Cavagnaro, 2 M (UCB); 7 km N on Pipeline Road near Gamboa, 28 Apr. 1975, M. L. Siri, 1 M (RWB); Canal Zone, Jul.-Aug. 1915, D. E. Harrow, 1 M (ANSP); 30 km SE of Colón, Santa Rita Ridge, 10 Apr. 1981, R. W. Brooks, 2 F (RWB). PANAMÁ PROV.: Cerro Campana, near Capira, 11 Aug.

1957, D. H. Janzen, 2 F (KU); 9 km N of El Llano, 7 Jan. 1981, on *Croton panamensis,* 1 M (LACM); 15 km N of El Llano, 7 May 1981, on *Psychotria,* R. W. Brooks, 1 M (RWB). *PERÚ:* HUÁNUCO PROV.: Huánuco Dpto., Tingo María, Monzon Valley, 12 Oct.-23 Dec. 1954, E. T. Schlinger and E. S. Ross, 8 M (CAS), 1 M (KU).

HABITS: The only females we have seen were those collected in Panamá by C. W. and M. E. Rettenmeyer on Barro Colorado Island, by D. H. Janzen at Cerro Campana, and by RWB 30 km SE of Colón (Santa Rita Ridge). Those collected by RWB were flying low along the side of a leaf-covered road, exposed to full sun, near midday and were presumably searching for suitable nest sites. Those collected by the Rettenmeyers were taken at a light between 0545 and 0615 h. Three males were taken at the same light. Females collected by Janzen were taken at a black light (Janzen, 1968). The male collected by RBR was taken by sweeping vegetation at midday. The male taken by RWB was taking nectar at *Psychotria* at midday. From this evidence, we believe that both sexes are usually matinal and that males may rest on vegetation or occasionally forage during the day.

DESCRIPTION: *MALE* (Figs. 1, 3j, 5d, 7d, f, 10j, 11a-b, 14j, 16b, 17i, 18k, 20m-n). Head and thorax dark metallic bluish black; metasoma pale amber to dark brown with yellow to amber bands on terga. Length 8.8-11.2 mm. Pubescence generally amber dorsally, becoming white ventrally. HEAD (Figs. 5d, 7d): Pubescence cream-colored, becoming dark brown at vertex as well as below and behind compound eye. (1) Labrum: Cream-colored; impunctate; distal margin with fimbria 1.0 od. (2) Clypeus: Cream-colored on lower half, amber to piceous above; convex; coarse punctures scattered throughout with rugae dorsally and laterally; pubescence simple and short (0.7 od) centrally, becoming longer (2.2 od) dorsolaterally. (3) Interocular area: Faintly metallic, especially laterally; surface concave in paraocular area and below median ocellus, low supraclypeal bulge below and between antennal sockets, indistinct median tooth (frontal tubercle) just below antennal sockets; coarse, contiguous punctures above antennal sockets but coarse punctures separated by at least their diameters below antennal sockets; pubescence between antennal sockets short (2.0 od), white and densely branched, mixed with long (3.5 od), brown, sparsely branched hairs; pubescence long and brown above antennal sockets (laterally), and below short, appressed and white, obscuring paraocular area. (4) Vertex: Piceous or faintly metallic; ocellar separation 0.5 od, lateral ocellus 1.8 od from eye, surface between eye and lateral ocellus distinctly concave, region behind ocelli scarcely rising before descending steeply to weak preoccipital carina; deep, moderate sized, contiguous punctures ventral to ocelli, becoming coarsely rugose posteriorly; pubescence 2.5 od between ocelli, becoming shorter anteriorly and laterally. (5) Gena: Faintly metallic purple to blue; convex behind eye; very faintly striate, hypostomal carina 1.45 times as long as width of proboscidial fossa; pubescence 3.8 od posteromedially, becoming shorter anteriorly and laterally. (6) Malar area: Amber to brown, 0.3 od between eye and mandibular base; pubescence white, short and dense. (7) Mandible: Amber; without teeth or ridges; sparse, golden hairs 3.1 od proximoventrally, becoming shorter distally. (8) Antenna (Fig. 3j): Brown to amber below, darker dorsally; flagellum 1.10 times head width, basal flagellomere 0.8 times as long as other individual flagellomeres, flagellomeres not sinuate. THORAX: Dull metallic bluish black to purplish black, legs amber to black. (9) Pronotum: Lateral angle and posterior lobe rounded; minutely rugose; pubescence short, appressed, white and flocculose, obscuring surface, and scattered, long plumose amber hairs (2.0 od). (10) Mesoscutum: Uniformly covered with small, deep, contiguous punctures; pubescence short, white and inconspicuous at margins and mixed with long plumose, amber hairs (2.4 od). (11) Mesoscutellum: Punctures like those of mesoscutum but slightly coarser; pubescence like that of mesoscutum. (12) Metanotum: Finely rugose; pubescence like that of mesoscutum but long hairs 3.6 od. (13) Mesepisternum: Finely rugose; pubescence like that of mesoscutum but amber on upper half and white on lower half. (14) Metepisternum: Finely rugose; pubescence 2.6 od. (15) Propodeum: Minutely rugose to contiguously punctate, posteromedial groove small. (16) Wings: Pubescence about as long as diameter of adjacent veins distally, becoming 0.6 od proximally, veins and stigma amber to brown, hamuli 10-12. (17) Tegula: Transparent amber; pubescence 2.0 od anteriorly, absent posteriorly. (18) Fore leg: Pale to dark brown; pubescence moderately dense, 2.8 od. Trochanter brown; pubescence 3.2 od posteriorly, shorter dorsolaterally. Femur light amber anteriorly, becoming dark amber posteriorly; pubescence 2.5 od posteriorly, becoming shorter anteriorly. Tibia like

femur but pubescence shorter (1.2 od posteriorly) and simple, strigilis with transparent velum and amber malus 2.2 od long. Tarsus pale to dark amber; tarsomeres 2-5 together 1.1 times as long as basitarsus; pubescence pale amber, short and dense ventrally, becoming darker and longer (6.5 od) dorsally. (19) Middle leg: Similar to fore leg, tibial spur simple (6.6 od long), tarsus amber to black, basitarsus equal in length to tibia and to tarsomeres 2-5 together. (20) Hind leg (Figs. 16b, 17i): Coxa amber to piceous; pubescence 3.4 od anteriorly and posteriorly, becoming shorter ventrally and absent dorsally. Trochanter amber; pubescence 1.2 od. Femur amber to piceous; somewhat swollen and with large, sharp, ventral tooth on mid section followed distally by concavity and second smaller blunt tooth; pubescence 3.1 od dorsally, becoming shorter elsewhere. Tibia amber to piceous; anterior spur 3.4 od long, posterior spur 3.7 od long (half as long as fused tarsomeres 12 together); pubescence 2.1 od and scattered anteriorly, becoming dense, short and directed distad ventrally. Tarsus with fused tarsomeres 12 0.6 times as long as tarsomeres 3-5 together; dense brush of distally directed bristles 1.3 od posteriorly on basitarsus, slightly longer anteriorly. METASOMA: (21) Terga (Figs. 11a-b): Pale amber (at least on anterior face of T1) to brownish black, with brownish yellow bands basally on T2-T3 or T1-T4; T1-T3 or T1-T4 with small lateral gradular carina (Figs. 1, 7f), postgradular area nearly flat with postgradular depression and premarginal ridge indistinct, T7 with broad but distinct pygidial plate (Fig. 14j); punctures contiguous and small on T1, becoming smaller and scattered on subsequent terga; pubescence on anterior face of T1 1.8 od, amber and branched, simple dark hairs laterally on T2-T7 and centrally on T3-T7 or T4-T7, short on anterior terga, becoming longer (6.9 od) on posterior terga. (22) Sterna (Fig. 10j): Amber; pubescence 7.0 od on S2, becoming shorter on posterior sterna, S4 with 5-8 medial spines hooking anteriorly. S7 and S8 (Fig. 18k). (23) Genitalia (Figs. 20m-n).

FEMALE (Figs. 3n, q, 8b, 9e). Agrees with description of male except as follows. HEAD (Figs. 8b, 9e): Without cream-colored markings on clypeus and labrum. (1) Labrum: Dark amber to black; basal area prominent, convex distomedially, concave proximally and laterally, irregularly rough and enclosed by flange; distal process broad and flat apically, lacking distomedial keel and lateral projections but with amber marginal fimbria of upturned bristles. (2) Clypeus: Coarsely punctate; fimbria of amber bristles directed ventrad (5.1 od) between lateral teeth on distal margin. (3) Interocular area: Without medial tooth (frontal tubercle) below antennal sockets; pubescence shorter than scape medially, not so dense and feathery as to obscure paraocular area. (5) Gena: Convex behind eye. (7) Mandible: With subapical tooth. (8) Antenna (Fig. 3q). THORAX: (15) Propodeum: Posterior surface with minute contiguous punctures and nearly enclosed by carina, posterodorsal surface with rugae radiating from metanotum; pubescence on posterior surface mixture of short appressed hairs and long (3.0 od) erect hairs. (18-20) Legs: Brown; pubescence typical of female Halictinae but distal tarsomeres of fore leg with slender, apically sinuate hairs; posterior spur of hind tibia with 6-8 flattened teeth (Fig. 3n). METASOMA: (21) Terga: Punctures slightly smaller than those of male, distinct lateral gradular carinae on T1-T4 or T1-T5; pubescence on anterior surface of T1 pale, minutely branched and 1.2 od, pubescence not discernible from posterior of T1 to anterior of T4, erect bristles on T4 and T5 black and 8.0 od. (22) Sterna: Pale yellowish amber anteriorly, darker posteriorly; pubescence long (5.9 od) and pale on anterior terga, becoming short (2.0 od) and dark posteriorly.

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THE UNIVERSITY OF KANSAS
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A Revision of the Genus *Bryanellocoris* with Thirty-five New Species from the Southwest Pacific (Hemiptera-Heteroptera: Lygaeidae)

By
Chen Jian-xiu and Peter D. Ashlock

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A Revision of the Genus *Bryanellocoris* with Thirty-five New Species from the Southwest Pacific (Hemiptera-Heteroptera: Lygaeidae)[1]

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Abstract

Thirty-five new species from New Guinea and the southwest Pacific are described in the genus *Bryanellocoris* Slater, which previously had only three species. The genus is reviewed and redescribed and a key to species provided.

Introduction

The genus *Bryanella* China was described for a single species, *Bryanella longicornis* China, 1930 from Samoa. Because the generic name was preoccupied, Slater (1957) renamed the genus *Bryanellocoris*. The genus hitherto included three species: *B. longicornis, B. orientalis* Hidaka, 1962 from islands just south of Japan, and *B. philippinensis* Slater, 1965 from the Philippine Islands. A fourth species, *Coryzus brevicollis* Motschulsky, 1863, was placed in this genus by Scudder (1970), but for several reasons it is not considered here. When Scudder made a lectotype of the specimen he had located in the Moscow University Museum, he listed the locality data on the specimen as "I. or Cyl. Mt. I." and stated that the species was described from "Des Montagnes de Nura-Ellia." Motschulsky's paper is titled "Essai d'un catalogue des insectes de l'ile Ceylan," and so the species would seem to be from Sri Lanka (Ceylon). Because the locality is far outside the range of other members of the genus and because specimens are not available, the species is not considered in this study.

Extensive collecting by the staff of the Entomology Department of the Bishop Museum shows that most species are found in New Guinea. Others are found in Japan, China (both mainland and Taiwan), the Bismarck Archipelago, etc. The genus is actually quite large, and 35 new species are described here. A few specimens have been excluded from consideration for various reasons. These specimens are discussed following the treatment of what appear to be closely related species.

Bryanellocoris is a member of the family Lygaeidae, subfamily Rhyparochrominae, tribe Ozophorini, most members of which feed on seeds and are found on the ground in

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litter. However, we know nothing of the biology of members of this genus. As in most ozophorines (see Ashlock and Slater, 1982), the fore femoral spines in all species of *Bryanellocoris* are compound; that is, each consists of an apical seta borne on a basal tubercle (Fig. 6). Within the tribe, *Bryanellocoris* belongs to a possible holophyletic group characterized by very short bucculae (Fig. 3) with a U-shaped posterior connection, and by a more or less prominent S-shaped carina on the jugum (Figs. 1-5). The group includes *Primierus* Distant, *Prosomoeus* Scott, *Paraporta* Zheng, *Porta* Distant, *Gressittocoris* Slater and Zheng, and *Tachytatus* Bergroth. Of these genera, *Primierus* and *Prosomoeus* have a stridulatory structure on the lateral edge of the hemelytron lacking in the other genera including *Bryanellocoris*. Members of *Porta, Primierus, Gressittocoris,* and *Paraporta* have erect spines on the humeral angles, while *Bryanellocoris* has only a low (rarely high) tubercle on the humeral angle and a lateral carina on the lateral angle (Figs. 1-5), which in some species is produced into a laterally explanate process or tooth that may be apically acute (Figs. 1, 2, 4A,F-J, 5A,D) or rounded (Fig. 4B-E). From all of these genera, *Bryanellocoris* may be distinguished by its relatively small size (under 7 mm long, mostly 4-6 mm) and by the short-legged, short broad body. All other genera mentioned are relatively large with long, narrow bodies and long legs.

The following redescription of *Bryanellocoris* is given because so many new species have been found that the original generic description (China, 1930) is no longer adequate.

Genus *Bryanellocoris* Slater

Bryanella China, 1930: 135-136. Preoccupied. Type species: *Bryanella longicornis* China, 1930, monobasic.

Bryanellocoris Slater, 1957: 37. New name for *Bryanella* China.

Head deflexed in most species (Fig. 3); length in most species slightly shorter to slightly longer than width including eyes; dorsal surface with sparse, small or fine punctures, sometimes a smooth area on each side of midline with a branch running laterally and curving around ocellus; appressed pubescence short and sparse on both dorsal and ventral surfaces, with sparsely scattered, long erect hairs sometimes also present dorsally; lateral margin of jugum with distinct S-shaped carina above antenna (Figs. 1-5); head usually dull textured dorsally and subshining below jugal carina; eye prominent, large or moderate in size, rarely small, with short stalk in some species (Figs. 3C, 4C-E); ocelli located behind a line drawn between posterior margins of eyes, nearly touching front margin of pronotum, farther from each other than from eyes; base of vertex between ocelli with short median longitudinal sulcus either deep, obscure, or absent; antenniferous tubercle moderately prominent viewed from above; buccula short, not extending posteriorly as far as level of insertion of antenna, with a U-shaped posterior connection between bucculae; labium sparsely covered with moderately long, erect hairs, apex reaching from in front of middle coxae to behind posterior edge of second visible abdominal segment; antenna long and slender, length varying from about 0.6 to 1.5 times length of body, segment II usually longest, segment I thickened, II and III thin, segment IV thickened and fusiform, all segments covered with sparse appressed pubescence. *Pronotum* strongly deflexed (Fig. 3); nearly glabrous, with a short appressed seta in each puncture, rarely with sparse, scattered, long, erect hairs; pronotum clearly divided into collar, anterior lobe, and posterior lobe (Figs. 1-5); collar and anterior lobe usually dull textured, with small shallow punctures spaced about 1 puncture diameter apart, lateral margin of anterior lobe convex, not carinate, callosities large, nearly meeting on midline, with from a few to as many as 30 punctures in center (Fig. 4); posterior lobe usually subshining, more sparsely and coarsely punctate, punctures from contiguous to 4 puncture diameters apart; two species (*B. cornutus,* n. sp. and *B. furcatus,* n. sp.) with a median anteriorly directed process on anterior part of posterior lobe, process surpassing anterior margin of pronotum, hollow, hornlike, simple (Fig. 4A) or furcate (Figs. 1, 4B) apically; lateral margin of posterior lobe nearly straight, not carinate except posterior part at humeral angle, posterior margin nearly straight or slightly sinuate, humeral angle with dorsal tubercle, never produced into an erect spine, lateral angle with carina (Figs. 1-5), carina sometimes explanate forming a laterally directed tooth with apex acute (Figs. 1, 2, 4A,F-J, 5A,D) or rounded (Fig. 4B-E), or carina narrow and blunt, neither explanate nor acute, to barely discernible (Fig. 5B,C,E-I); collar usually narrow, width rather

less than one-half length of anterior lobe; length on midline of anterior lobe plus collar from two-fifths of to equal to length of posterior lobe on midline. *Scutellum* usually with sparse, small, shallow punctures and dull textured basally, more coarsely punctate and subshining apically; seta in each puncture usually short and appressed except a few species with sparse, scattered, long, erect hairs; median length about equal to width at base; midline of apical half usually elevated and with 2 arms in front forming a Y-shaped carina (Figs. 1, 2). *Hemelytron* always macropterous, usually subshining, varying from glassy to comparatively dull; usually with short appressed seta in each puncture, or with sparse, scattered, long, erect hairs in a few species (Figs. 2, 3B), membrane at least slightly exceeding abdomen; clavus with 3 rows of punctures, odd rows along anterior and posterior margins definite and regular, median row rather irregular (Figs. 1, 2, 8A); corium with a distinct row of punctures adjacent to claval suture and a row along membranal margin, and with costal margin slightly sinuate, emarginate at level of apex of scutellum, widest at level of apex of claval commissure, apical three-fourths distinctly reflexed (Figs. 1, 8). *Thorax* usually dull textured ventrally except mesosternum with polished area not bounded by a carina, punctate except posterior metapleural plate; posterior metapleural plate separated from rest of pleuron by a distinct linear impression with deep punctures (Fig. 3); legs slender, fore coxal tubercle or spine over trochanter lacking in most species, but present in a few (Fig. 7A), femora not incrassate, fore femur ventrally armed with 1 to 6 (commonly 2 subapical) compound spines consisting of basal tubercle and apical seta (Figs. 1, 2, 6, 7A), tubercle either elongate and cylindrical, usually longer than apical seta (Figs. 6A-D,F, 7A), or short and conical, usually shorter than seta (Fig. 6H-J), tubercle and seta of the same or different colors (ventral surface of hind femur of *B. fijiensis,* n. sp., usually with a long, fine, subapical spine lacking a basal tubercle; Fig. 7B), middle and hind tibiae each with 2 rows of distinct spines on posterior and outer sides, hind tibia with several additional apical spines (Fig. 7C). *Abdomen* subshining, impunctate, densely covered with short or moderately long, appressed, pale pilosity; all abdominal spiracles ventral. *Spermatheca* simple, duct long and thin without enlarged sections, coiled 2 or 3 times, distal bulb oval, sometimes slightly elongate or irregular (Fig. 9), differences among species not sufficient to be valuable for classification.

Because the study of the eastern hemisphere Ozophorini has yet to reach a satisfactory stage, a cladistic analysis of the group in general and the genus *Bryanellocoris* in particular is premature. The following notes, however, are meant to give preliminary indications of relationships within the genus.

A start at the generic level has been presented by Slater and Zheng (1985), who studied the genera *Prosomoeus, Primierus,* and *Porta,* adding a new genus, *Gressittocoris.* These genera form, according to the authors, a holophyletic group because the lateral abdominal suture 4-5 is straight and fused, a reversal of the derived character relating most tribes of Rhyparochrominae. These four genera, along with *Tachytatus, Paraporta,* and *Bryanellocoris,* form a larger holophyletic group as indicated by a dorsolateral carina along the jugum, found in no other ozophorine.

Bryanellocoris may be the most primitive in this group of seven genera. Its members retain the curved abdominal suture 4-5, and the body, unlike that in any other genus, is short and has short legs; this condition is common in many primitive groups of Rhyparochrominae.

Bryanellocoris has several characters that are unique within the holophyletic group of seven genera. The first 18 species in this study have the lateral pronotal carina variously expanded at the humeral angle (not to be confused with the humeral spine of *Gressittocoris, Primierus,* and *Porta,* which is not derived from the carina).

The remaining 20 species (numbers 19 through 38), then, are the more primitive members of the genus. All have two fore femoral spines (though *B. longirostrus* sometimes has three and individuals of *B. adustus* and *B. maculatus* may have but a single spine). All but two of these species are confined to New Guinea. The exceptions are the widespread *B. orientalis* (China and islands south of the main islands of Japan, but not New Guinea) and *B. philippinensis,* which is confined to the Philippines. Seven of these species *(B. spinulus, B. gressitti, B. rostellus, B. piceus, B. notatus, B. planifrons,* and *B. gagnei)* have the head with a flat vertex rather than the more primitive convex vertex common throughout the subfamily. Species are distin-

guished in this group primarily by color patterns, but segment lengths of the labium and antenna and details of the fore femoral spines are also useful.

The more derived group in the genus, those with an expanded humeral carina (species 1-18), is much easier taxonomically because it is rich in morphological characters. Two species, *B. cornutus* and *B. furcatus,* share a character we believe to be unique in the Lygaeidae, the median pronotal horn. Three species *(B. megalopus, B. exophthalmus,* and *B. oculatus)* have stalked eyes. Two species *(B. cretatus* and *B. coxaspinosus)* have fore coxal spines, unique in the Ozophorini. Three species *(B. pilosus, B. longicornis,* and *B. fijiensis)* have long pronotal hairs, and *B. pilosus* in addition has long hairs on the first antennal segment.

All but two of the more advanced group have the head with a flat vertex. Anomalously, *B. pilosus* and *B. longicornis* have a convex vertex. The vertex posteriorly has a deep pit or sulcus in *B. exophthalmus, B. cretatus, B. hexacanthus, B. humeralis, B. longirostrus, B. fijiensis, B. strongylus,* and *B. microrommatus,* and several other species show a shallow or obsolete sulcus, but this signifer forms no obvious cladistic pattern. Again, most species in this group have two fore femoral spines, but seven species have more: *B. cretatus* (4), *B. coxaspinosus* (4), *B. hexacanthus* (6), *B. magnacornis* (4), *B. globosus* (4), *B. humeralis* (3-4), and *B. hebridensis* (2-4). The type of the genus, *B. longicornis,* has a single fore femoral spine.

Many of the more advanced group are confined to New Guinea *(B. cornutus, B. furcatus, B. exophthalmus, B. oculatus, B. hexacanthus, B. strongylus,* and *B. microrommatus),* while others are found in New Guinea and elsewhere as well: *B. megalopus* and *B. humeralis* are also found in the Solomon Islands, while *B. magnacornis* also lives in New Ireland. The remaining species in the group are not found in New Guinea: *B. cretatus* is known only in New Britain; *B. coxaspinosus,* in the Solomons; *B. globosus,* in Borneo; *B. hebridensis,* in the New Hebrides; *B. pilosus,* in Java; *B. longicornis,* in Samoa; and *B. fijiensis,* in Fiji.

The picture is of a genus whose primitive members have an unornamented pronotum with a simple lateral carina, the vertex of the head convex but with a carina on each jugum, and with the fore femora armed with two compound spines. The group probably began its evolution in New Guinea, and has several times migrated to other localities. Vicariance seems to have played little or no part in this distribution, though more widespread collecting could certainly change this picture.

KEY TO SPECIES OF *BRYANELLOCORIS*

Species descriptions are numbered for ease of reference in the text. These numbers are also used in the key.

1. Humeral angle of pronotum laterally with broadly explanate carina (Figs. 1, 2, 4, 5A,D), sometimes acute apically (Figs. 1, 2, 4A,F-J, 5A-D); fore femur with from 1 to 6 spines 2
— Humeral angle of pronotum with at most barely discernible carina, never explanate or acute (Fig. 5B,C,E-I); fore femur usually with 2 subapical spines 19
2(1). Posterior lobe of pronotum with single median elongate hornlike process, projecting toward head (Figs. 1, 4A,B). 3
— Posterior lobe of pronotum never with medial hornlike process . . . 4
3(2). Median hornlike process simple, tip at most slightly depressed but never furcate; explanate humeral carina acute (Fig. 4A). NEW GUINEA . . . . . 1. *B. cornutus*
— Median hornlike process furcate apically; explanate humeral carina rounded (Figs. 1, 4B). NEW GUINEA . . . . . 2. *B. furcatus*
4(2). Eye stalked (Figs. 3C, 4C-E); fore femur with 2 subapical spines . . 5
— Eye sometimes prominent but not stalked (Figs. 1, 2, 3A,B, 4A,B,F-J, 5); fore femur with from 1 to 6 spines 7
5(4). Eye large with stalk directed upward (Fig. 3C), width of interocular

space twice width of eye (Fig. 4C) and at most about equal to length of antennal segment I; femur with imprecise subapical brown band; fore femoral subapical spines strong, elongate, unicolored, with basal tubercle cylindrical and much longer than apical seta (Fig. 6C); carina of humeral angle large (Fig. 4C); labium short, reaching only front edge of middle coxae. New Guinea, Solomon Is. . . . . 3. *B. megalopus*

— Eye moderate to small with stalk directed laterally, width of interocular space 3 to 4 times width of eye (Fig. 4D,E) and at least one-fourth more than length of antennal segment I; femur unicolored; fore femoral subapical spines weak, bicolored, with basal tubercle conical and much shorter than apical seta (Fig. 6H); carina of humeral angle small (Fig. 4D,E); labium long, reaching hind coxae 6

6(5). Eye small, width of interocular space 4 times width of eye (Fig. 4D); antennal segment II much shorter than greatest width of pronotum including humeral carinae; humeral tubercle prominent, projecting strongly upward. New Guinea . . . . . 4. *B. exophthalmus*

— Eye moderate in size, width of interocular space 3 times width of eye (Fig. 4E); antennal segment II at least about equal to greatest width of pronotum including humeral carinae; humeral tubercle small and inconspicuous. New Guinea . . . . . 5. *B. oculatus*

7(4). Fore coxa with prominent tubercle or spine above trochanter (Fig. 7A); fore femur with 4 spines. 8

— Fore coxa without tubercle or spine above trochanter; fore femur with 1 to 6 spines 9

8(7). Antennal segment III with apical three-eighths white, strongly contrasting with remaining part; hemelytron strongly patterned with dark and pale; humeral carina very prominent and acute (Fig. 4F), strongly projecting obliquely upward and longer laterally than upward projection of humeral tubercle; femur with subapical dark band narrower than one-half length of femur, fore femur only slightly thicker than middle or hind femur, with dorsal and ventral sides subparallel (Fig. 7A). New Britain . . . . . 6. *B. cretatus*

— Antennal segment III at most with apical one-seventh pale or yellowish white, not strongly contrasting with remaining part; pattern on hemelytron not pronounced; humeral carina prominent and acute (Fig. 4G), but projecting upward only slightly and shorter laterally than upward projection of humeral tubercle; femur with subapical band wider than one-half length of femur, fore femur much thicker than middle or hind femur, with middle part very convex. Solomon Is. . . . . 7. *B. coxaspinosus*

9(7). Labium reaching at least to hind margin of hind coxae, all femora with a broad, brown, definite subapical band; posterior lobe of pronotum usually with 2 somewhat transverse dark spots on anterior margin. New Guinea . . . . . 9. *B. incultus*

— Labium reaching at most to base of hind coxae; subapical femoral band, if present, not in strong contrast on pale femur; posterior lobe of pronotum lacking dark spots on anterior margin 10

10(9). Corium with a pale spot within apical dark spot (Fig. 8A); fore femur with 2 to 6 spines 11

— Corium without a pale spot within apical dark spot (Figs. 1, 2, 8B); fore femur with 1 or 2 subapical spines. 15

11(10). Fore femur with 4 to 6 spines; antennal segment I at least one-sixth longer than interocular space plus one eye; antennal segments II and III each much longer than greatest width of pronotum including

humeral carinae 12

— Fore femur with 2 to 4 (rarely 5) spines; antennal segment I usually shorter or rarely slightly longer than interocular space plus one eye; antennal segments II and III each shorter than or at most only segment II slightly longer than greatest width of pronotum including humeral carinae 13

12(11). Antennal segment I one-fifth longer than width of head including eyes; fore femur with 6 spines. NEW GUINEA . . . . . 8. *B. hexacanthus*

— Antennal segment I as long as or slightly shorter than width of head including eyes; fore femur with 4 spines. NEW GUINEA, NEW IRELAND . . . . . 10. *B. magnacornis*

13(11). Anterior lobe of pronotum plus collar subequal to posterior lobe in length (Fig. 4I); fore femur with 4 (rarely 5) spines; humeral carina small. SABAH (N. BORNEO) . . . . . 11. *B. globosus*

— Anterior lobe of pronotum plus collar at most two-thirds as long as posterior lobe (Fig. 4J); fore femur with 2 to 4 spines; humeral carina large 14

14(13). Antennal segment I with both ends pale; length of antennal segment II about equal to greatest width of pronotum including humeral carinae; antennal segment III much longer than IV, with yellowish-white apical band; fore femur with 3 to 4 spines. SOLOMON IS. NEW GUINEA . . . . . 12. *B. humeralis*

— Antennal segment I with only basal end pale; antennal segment II shorter than greatest width of pronotum including humeral carinae; antennal segment III at most slightly longer than IV, without pale apex; fore femur with 2 to 4 spines. NEW HEBRIDES . . . 13. *B. hebridensis*

15(10). Antennal segment I densely clothed with long, thick, dark erect hairs, hairs longer than greatest width of segment (Fig. 2, 3B); fore femur with 2 subapical spines set close together, with basal tubercle cylindrical and longer than apical seta (Fig. 6D). JAVA . . . . 14. *B. pilosus*

— Antennal segment I without long erect hairs, clothed with appressed pale hairs, hairs shorter than greatest width of segment; fore femur with 1 or 2 subapical spines, if 2 not very close together (Fig. 6E,J) 16

16(15). Fore femur with at most 1 tiny, weak, unicolored subapical spine with conical basal tubercle much shorter than apical seta (Fig. 6J); dorsal surface of body with sparse, scattered long, erect hairs arising from punctures. SAMOA . . . . . 15. *B. longicornis*

— Fore femur with 2 strong subapical spines each with basal tubercle long and cylindrical; dorsal surface of body except head without long erect hairs or with hairs arising from between punctures. 17

17(16). Eye large, width of interocular space less than 3 times width of eye (Fig. 5D), median sulcus at base of vertex deep; sparse, scattered, erect hairs long on dorsal surface of head and anterior lobe of pronotum, moderately long on posterior lobe of pronotum, scutellum, and hemelytra; fore femoral subapical spine bicolored; ventral side of hind femur usually with long, fine, subapical spine with no basal tubercle (Fig. 7B); labium short, reaching only between fore and middle coxae; hemelytron conspicuously patterned with dark and pale. FIJI . . . . . 16. *B. fijiensis*

— Eye small, width of interocular space more than 3 times width of eye, median sulcus at base of vertex absent or very obscure; body except head dorsally without long erect hairs; fore femoral subapical spine bicolored to nearly unicolored; hind femur without subapical spine; labium long, reaching middle coxae; hemelytron not contrastingly patterned with dark and pale 18

18(17). Antennal segment I longer than width of interocular space; fore femoral subapical spine with apical seta about as long as basal tubercle; humeral carina rounded laterally. New Guinea . . . . 17. *B. strongylus*

— Antennal segment I shorter than width of interocular space; fore femoral subapical spine with apical seta longer than basal tubercle (Fig. 6E); humeral carina acute with anterior margin curved and posterior margin straight. New Guinea . . . . . 18. *B. micrommatus*

19(1). Labium not exceeding middle coxae 20

— Labium at least reaching hind coxae 24

20(19). Corium with a pale spot within apical dark spot (Fig. 8A); antennal segment IV with proximal pale band; sparsely scattered, erect hairs long on dorsal surface of head and collar, moderately long along lateral margin of anterior pronotal lobe. Japan, Ryukyus, China, including Taiwan . . . . . 19. *B. orientalis*

— Corium without a pale spot within apical dark spot (Figs. 1, 2, 8B); antennal segment IV unicolored; body except dorsal surface of head without long or moderately long, erect hairs 21

21(20). Labial segment II long, equal to antennal segment I, equal to or only slightly shorter than labial segment I, much longer than last 2 labial segments; fore femoral subapical spine weak, with basal tubercle conical and equal to or shorter than apical seta. New Guinea . . . . . 20. *B spinulus*

— Labial segment II short, much shorter than antennal segment I or labial segment I, subequal to or only slightly longer than last 2 labial segments; fore femoral subapical spine strong, at least distal subapical spine with basal tubercle cylindrical and usually longer than apical seta 22

22(21). Femora with conspicuous subapical brown band 23

— Femora unicolored. New Guinea . . . . . 21. *B. gressitti*

23(22). Body not very dark, not blackish brown, dull or subshining; head moderately deflexed. New Guinea . . . . . 22. *B. rostellus*

— Body dark, nearly blackish brown, glassy and shining; head strongly deflexed. New Guinea 23. *B. piceus*

24(19). Membrane with median fan-shaped dark spot posteriorly (Fig. 8B) . 25

— Membrane without fan-shaped dark spot (Figs. 1, 2) 31

25(24). Both fore femoral subapical spines with basal tubercle cylindrical and longer than apical seta 26

— At least second fore femoral subapical spine with basal tubercle conical and shorter than apical seta 28

26(25). Second fore femoral subapical spine longer than distal spine (Fig. 6F); head slightly deflexed (Fig. 3A), with anteocular length viewed from above more than length of eye (Fig. 5C). New Guinea . . . . . 24. *B. porrectus*

— Second fore femoral subapical spine shorter than distal spine; head moderately or strongly deflexed, with anteocular length viewed from above less than length of eye (Fig. 5F) 27

27(26). Dorsum slightly patterned with dark and pale; femoral subapical band distinct and dark brown on hind femur; head nearly flat between eyes, with vertex much lower than top of eyes. New Guinea . . . . . 25. *B. notatus*

— Dorsum contrastingly patterned with dark and pale; all femoral subapical bands obscure and light brown; head convex between eyes, with vertex as high as top of eyes. New Guinea . . . 26. *B. samuelsoni*

28(25). Venter of abdomen, femur including spines, antennal segments I and IV strongly suffused with red; fore femoral subapical spine uni-

colorous. NEW GUINEA . . . . . 27. *B. russatus*

— Body not so strongly suffused with red; fore femoral subapical spine bicolored 29

29(28). Labium exceeding posterior edge of second visible abdominal segment, labial segment III long, equal to or longer than I or II and much longer than IV; antennal segment I much (about two-fifths) longer than width of interocular space; antennal segment II long, length subequal to greatest width of pronotum. NEW GUINEA . . . . . 28. *B. longirostrus*

— Labium rarely reaching posterior edge of second visible abdominal segment, labial segment III short, at most longer than IV but shorter than I or II; antennal segment I slightly (at most one-fifth) longer than width of interocular space; length of antennal segment II about two-thirds greatest width of pronotum 30

30(29). Body very dark (blackish brown); at least hind femur with distinct dark brown subapical band. NEW GUINEA . . . . . 29. *B. adustus*

— Body evenly pale; femora without or at most with very obscure light brown subapical band. NEW GUINEA . . . . . 30. *B. antennellus*

31(24). At least distal fore femoral subapical spine with basal tubercle cylindrical and usually strong and longer than apical seta (Fig. 6G) 32

— Both fore femoral subapical spines with basal tubercle conical and usually weak and shorter than apical seta (Fig. 6I) 35

32(31). Dorsal surface of head, pronotum and scutellum with sparse scattered, long, erect hairs arising from between punctures; labial segment III much longer than any other segment. PHILIPPINES . . . . . 31. *B. philippinensis*

— Dorsal surface of body except head without long erect hairs; labial segment I longest 33

33(32). Length of antennal segment I subequal to width of interocular space; labial segment III only slightly shorter than I or II, and much (at least one-half) longer than IV; both fore femoral subapical spines with each basal tubercle cylindrical and longer than apical seta. NEW GUINEA . . . . . 32. *B. sedlaceki*

— Antennal segment I at least one-sixth longer than width of interocular space; labial segment III much shorter than I or II, and at most slightly (one-sixth) longer than IV; second fore femoral subapical spine with basal tubercle usually conical and shorter than apical seta (Fig. 6G) 34

34(33). Body comparatively dark, pronotum and scutellum often with black spots; femur with both basal and subapical bands dark brown and strongly contrasting with remaining parts (Fig. 6G); first two labial segments each longer than antennal segment I. NEW GUINEA . . . . . 33. *B. impensus*

— Body less dark, pronotum and scutellum without black spots; femur at most with obscure light brown subapical band; labial segment I slightly longer than antennal segment I, labial segment II shorter than antennal segment I. NEW GUINEA . . . . . 34. *B. tensus*

35(31). Femur unicolored, without subapical brown band; hemelytron evenly pale. NEW GUINEA . . . . . 35. *B. unicolor*

— Femur at least with conspicuous light brown subapical band (Fig. 6I); hemelytron dark or conspicuously patterned with dark and pale 36

36(35). Head slightly deflexed, with anteocular length viewed from above longer than eye length; head strongly convex between eyes, with vertex much higher than top of eyes; femur with both basal and subapical bands blackish brown and strongly contrasting with remaining

parts (Fig. 6I). New Guinea . . . . . 36. *B. maculatus*

— Head moderately or strongly deflexed, with anteocular length viewed from above shorter than or at most subequal to eye length; head flat between eyes, with vertex much lower than top of eyes; femur without basal dark band 37

37(36). Body dark; fore femur with conspicuous dark brown subapical band; head strongly deflexed, with anteocular length viewed from above much less than eye length. New Guinea . . . . . 37. *B. planifrons*

— Body light; fore femoral subapical band light brown and comparatively obscure; head moderately deflexed, with anteocular length viewed from above slightly less than eye length. New Guinea . . . . . 38. *B. gagnei*

Descriptions of Species

Preliminary investigation of the genitalia showed little of promise, and these features are not described. All measurements are in millimeters. Basal and apical lengths of the membrane refer to (1) a measurement on the midline of the insect from the apex of the claval commissure to the level of the apices of the coria (basal), and (2) from this point to the apex of the membrane (apical). Descriptions of new species are from the holotypes, and important variation is indicated in parentheses. Likewise for previously described species, descriptions are based on single specimens and variation indicated in parentheses.

All specimens are from the Bishop Museum, Honolulu, Hawaii, and are deposited there except for paratypes retained by the authors; the paratype of *B. philippinensis* and 2 specimens of *B. orientalis* collected in Japan were borrowed from J. A. Slater. Collectors' names are abbreviated as follows: BJFJr, B. J. Ford, Jr.; EHBJr, E. H. Bryan, Jr.; GAS, G. A. Samuelson; JLG, J. Linsley Gressitt; JL&MG, J. L. & M. Gressitt; JMS, J. M. Sedlacek; JS, J. Sedlacek; NLHK, N. L. H. Krauss; SQ&LQ, S. Quate & L. Quate; WCG, W. C. Gagné; WWB, W. W. Brandt.

1. *Bryanellocoris cornutus* Chen & Ashlock, n. sp.

Fig. 4A

Head moderately deflexed, with anteocular length viewed from above slightly longer than (or about equal to) eye length (0.17:0.17); vertex nearly flat between eyes; median sulcus at base of vertex shallow or absent; head length 0.72, width including eyes 0.79; anteocular length 0.34, width of interocular space 0.50; eye moderate in size, not stalked, with top lower than vertex, eye length 0.21, width 0.15; labium reaching front edge of hind coxae (or middle coxae), basal segment not quite reaching prosternum, segment lengths from base 0.51, 0.46, 0.31, 0.34; antennal segment I about twice as thick at middle as second segment, segment lengths from base 0.58, 1.17, 0.93, 0.83. *Pronotum* with collar having small shallow punctures; lateral margin of anterior lobe slightly (or moderately) convex; callosity nearly impunctate with 2 to 4 punctures medially; anterior part of posterior lobe with a median, forward-directed process surpassing anterior edge of pronotum, process thick, hollow, hornlike, with apex simple (or at most slightly impressed) but never furcate; humeral angle with dorsal tubercle moderate in size, and laterally directed carina usually small (or moderate) in size, rounded (or acute) apically, with anterior margin curved and posterior margin straight and oblique to longitudinal axis of body; median length of pronotum 0.86, length of anterior lobe plus collar about one-half length of posterior lobe (0.27:0.58), width across collar 0.65, greatest width including humeral carinae 1.48. *Scutellum* with slightly elevated central part of disc forming an inconspicuous Y-shaped carina; median length 0.72, width at base 0.75. *Hemelytron* exceeding abdomen by about one-half apical length of membrane (length of membrane variable, often long, exceeding abdomen by about two thirds apical length, or short, only slightly exceeding abdomen); length of corium 2.14, length of claval commissure 0.65, basal length of membrane 0.96, apical length 1.06. *Thorax* ventrally with fine punctures; fore femur armed with 2 elongate, bicolored, subapical spines with tubercle of each spine cylindrical and much longer than apical seta. *Color.* Head, collar, anterior lobe and humeral carina of pronotum, venter of thorax except acetabulae and posterior metapleural plate, and base of scutellum dark reddish brown, acetabulae and posterior metapleural plate pale; venter of abdomen yellowish brown; remaining parts with ground color pale yellowish brown.

Hemelytron patterned with pale areas on clavus near apex, and on corium at inner angle and along costal margin, and with dark spots on corium apically and along costal margin at two-thirds of distance from base. Membrane pale, unpatterned (or with obscure dark pattern consisting of a medial V-shaped mark, a streak on each side from near apex of V running laterally and somewhat posteriorly to lateral margin, a streak along posterior margin of corium, and a median T-shaped spot in front of V with an oval white spot on each side). Femora pale yellowish brown with subapical band vague and light brown, tibiae yellowish brown with apex and subbase slightly darker. Antennal segment I dark yellowish brown (often with both ends slightly pale), segments II and III yellowish brown with apex slightly dark, segment IV dark yellowish brown. Labial segment I yellowish brown, II and III pale yellowish brown, apex dark. Length of holotype 4.06.

Holotype male, INDONESIA (IRIAN JAYA): Wisselmeren, Urapura Itouda, Kamo Valley, 1500 m, VII-15-1965, JLG. *Paratypes,* PAPUA NEW GUINEA: East Sepik District, 1 male, Yaibos, 2030-2180 m, VII-11-1963, JS; Madang District, 1 male, 1 female, Mt. Wilhelm, 3000 m, VII-4-1955, JLG; Morobe District, 1 male, Salawaket Range, Sepalakembang, 1920 m, IX-12-1956, light trap, BJFJr, 1 female, Edie Creek, 15 km SW Wau, XI-22-1963, JLG, 4 females, E end Salawaket Range, 20 km SSW Kabwum, 2550 m, VIII-5 to 12-1966, GAS; Southern Highlands District, 1 female, Mendi, 1660 m, X-8 1958, JLG, 1 male, Mt. Giluwe, 2550 m, V-29-1963, JS.

Etymology: Cornutus, L. for horn, referring to the pronotal hornlike process.

2. *Bryanellocoris furcatus* Chen & Ashlock, n. sp.

Figs. 1, 4B

Head moderately deflexed, with anteocular length viewed from above slightly longer than (or equal to) eye length (0.24:0.21); vertex nearly flat between eyes; median sulcus at base of vertex shallow; head length 0.75, width including eyes 0.88; anteocular length 0.38, width of interocular space 0.54; eye moderate in size, not stalked, with top lower than vertex, eye length 0.24, width 0.17; labium short, reaching middle coxae, basal segment not quite reaching prosternum, segment lengths from base 0.53, 0.50, 0.50, 0.38; antennal segment I about twice as thick at middle as segment II, segment lengths from base 0.80, 1.58, 1.17, 1.17. *Pronotum* with collar having small shallow punctures; lateral margin of anterior lobe moderately convex, callosity nearly impunctate with 2 to 4 punctures in center; anterior part of posterior lobe with a forward-directed median process surpassing anterior edge of prosternum, process thick, hollow, hornlike, furcate apically; humeral angle with dorsal tubercle small and inconspicuous, and laterally directed carina large (or moderate) in size, rounded (or acute) apically with anterior margin rounded and posterior margin straight and perpendicular to longitudinal axis of body (or slightly slanted forward); median length of pronotum 1.10, length of anterior lobe plus collar less than one-half length of posterior lobe (0.31:0.79), width across collar 0.74, greatest width including humeral carinae 2.06. *Scutellum* with slightly elevated central part of disc forming an inconspicuous Y-shaped carina; median length 0.96, width at base 0.96. *Hemelytron* exceeding abdomen by about one-half apical length of membrane; length of corium 3.09, length of claval commissure 0.62, basal length of membrane 1.48, apical length 1.48. *Thorax* ventrally with fine punctures; fore femur armed with 2 elongate, bicolored, subapical spines with tubercle of each spine cylindrical and much longer than apical seta. *Color.* Head, collar, anterior lobe and humeral carina of pronotum, venter of thorax except acetabulae and posterior metapleural plate, and base of scutellum dark reddish brown, acetabulae and posterior metapleural plate pale; venter of abdomen dark yellowish brown; remaining parts with ground color pale yellowish brown. Hemelytron patterned with pale areas on clavus near apex, and on corium at inner angle and along costal margin, and with dark spots on corium apically and along costal margin at two-thirds of distance from base. Membrane unpatterned (or with very obscure dark pattern). Femora pale yellowish brown with subapical band imprecise and brown, tibiae yellowish brown with both apex and subbase slightly darker. Antennal segments I-III yellowish brown, segment I with both ends slightly pale, II with both ends slightly dark, segment IV dark yellowish brown (or dark reddish brown). Labial segment I yellowish brown, remaining segments pale yellowish brown, apex dark. Length of holotype 5.83.

Holotype female, PAPUA NEW GUINEA: Morobe District, Mt. Kaindi, 2360 m, XII-12-1976, WCG. *Paratypes,* PAPUA NEW GUINEA: Central District, 1 female, Owen Stanley Range, Goilala, Bome, 1950 m, IV-30 to V-2-1958, WWB, 1 female, NE Iongai, 1800-1850 m, XI-8 to 10-1965, JS; Morobe District, 1 female, Wau, 1200 m, X-11 to 15-1961, JS, 2 males, Wau, Edie Creek, 2000 m, VIII-13-1963, "H.C.," collector

FIG. 1. Dorsal view of paratype of *Bryanellocoris furcatus*.

unknown, 1 male, Wau, Mt. Kaindi, 2350 m, IV-16 to V-7-1973, Malaise trap, JLG, 1 female, E Bulldog Road, 2400-3000 m, VI-17 to 20-1978, light trap, WCG.

Etymology: Furcatus, L. for forked, referring to the branched pronotal horn.

3. *Bryanellocoris megalopus* Chen & Ashlock, n. sp.

Figs. 3C, 4C, 6C

Head strongly deflexed, with anteocular length viewed from above much less than eye length (0.07:0.31); vertex flat between eyes; median sulcus at base of vertex obscure (or absent); head length 0.79, width including eyes 1.10; anteocular length 0.31, width of interocular space 0.57; eye large, stalked, with top much higher than vertex, eye length 0.33, width 0.27; labium short, reaching middle coxae, basal segment reaching front edge of prosternum, segment lengths from base 0.50, 0.31, 0.27, 0.34; antennal segment I about 3 times as thick at middle as segment II, segment lengths from base 0.58, 1.34, 0.93, 1.27. *Pronotum* with moderately long, erect hairs on lateral edge of anterior lobe; seta in each puncture with length about equal to or slightly more than puncture diameter; collar impunctate dorsally, lateral margin of anterior lobe moderately convex, callosity nearly impunctate with 3 or 4 punctures in center; humeral angle with dorsal tubercle conspicuous and laterally directed carina moderate in size (or large), rounded apically with both anterior and posterior margins rounded; median length of pronotum 1.27, length of anterior lobe plus collar about one-half length of posterior lobe (0.43:0.84), width across collar 0.79, greatest width including humeral carinae 1.89. *Scutellum* with elevated central part of disc forming a Y-shaped carina; median length 0.93, width at base 0.89. *Hemelytron* exceeding abdomen by about one-half apical length of membrane; length of corium 2.74, length of claval commissure 0.65, basal length of membrane 1.30, apical length 1.10. *Thorax* ventrally with sparse, coarse punctures; fore femur armed with 2 strong, elongate, unicolored, subapical spines with proximal tubercle of each spine cylindrical and much longer than apical seta. *Color.* Head, collar, anterior lobe and lateral carina of pronotum, venter of thorax except acetabulae and posterior metapleural plate, and base of scutellum dark reddish brown, acetabulae and posterior metapleural plate pale; scutellum with central carina pale and apical one-third dark brown; remaining parts with ground color pale yellowish brown. Hemelytron with pale areas on clavus near apex, and on corium at inner angle, each surrounded by large dark spot, and pale area along costal margin with dark spots at one-quarter and two-thirds of distance from base. Membrane with obscure dark pattern consisting of a medial V-shaped mark and a streak on each side from near apex of V running laterally and somewhat posteriorly to lateral margin. Femora pale yellowish brown with subapical band imprecise and light brown, tibiae pale yellowish brown with apex and subbase slightly dark. Antennal segment I yellowish brown with apical one-quarter pale, II and III pale yellowish brown, segment IV brown. Labial segment I brown, other segments yellowish brown, apex black. Length of holotype 4.60.

Holotype female, PAPUA NEW GUINEA: Morobe District, Lae, I-29-1978, on *Leucosyke* sp., WCG. *Paratypes,* 4 males, 2 females, same data as holotype; PAPUA NEW GUINEA: Western Highlands District, 1 male, Wum, Upper Jimi Valley, 840 m, VII-17-1955, JLG; SOLOMON ISLANDS: 1 female, Choiseul Is., Malangona, 30 m, III-14-1964, on *Leucosyke* sp., P. Shanahan.

Etymology: Megalopus, G. for large eyed.

4. *Bryanellocoris exophthalmus* Chen & Ashlock, n. sp.

Fig. 4D

Head strongly deflexed, with anteocular length viewed from above about equal to eye length (0.14:0.14); vertex flat and broad between eyes; nearly glabrous and subshining dorsally, subshining ventrally with pubescence short and sparse; median sulcus at base of vertex deep, forming a small rounded depressed pit as large as ocellus; head length 0.65, width including eyes 0.82; anteocular length 0.36, width of interocular space 0.55; eye small, stalked, with top higher than vertex, eye length 0.15, width 0.14; labium short, reaching middle coxae, basal segment reaching front edge of prosternum, segment lengths from base 0.51, 0.46, 0.34, 0.24; antennal segment I about 3 times as thick at middle as segment II, segment lengths from base 0.41, 0.89, last two missing. *Pronotum* with collar having small shallow punctures, subshining and large, about equal to one-half anterior lobe in length (0.12:0.19); anterior lobe with lateral margin moderately convex, callosity nearly impunctate with 4 or 5 small punctures in center; humeral angle with dorsal tubercle prominent, strongly projecting upward, and laterally directed carina moderate in size, rounded apically with anterior margin rounded and posterior margin nearly straight and oblique to longitudinal axis of body; median length of pronotum 0.77, length of anterior lobe plus collar about two-thirds length of posterior lobe

(0.31:0.46), width across collar 0.62, greatest width including humeral carinae 1.25. *Scutellum* with slightly elevated central part of disc forming an inconspicuous Y-shaped carina; median length 0.55, width at base 0.58. *Hemelytron* exceeding abdomen by about one-third apical length of membrane; length of corium 1.78, length of claval commissure 0.69, basal length of membrane 0.82, apical length 0.51. *Thorax* ventrally with dense, fine punctures; fore femur armed with 2 moderate-sized, bicolored, subapical spines with basal tubercle of each spine conical and much shorter than apical seta. *Color.* Head, anterior lobe and humeral angle of pronotum, venter of thorax except acetabulae and posterior metapleural plate, and basal part of scutellum dark reddish brown, acetabulae and posterior metapleural plate pale; apical two-thirds of scutellum brown with tip and median stripe pale; remaining parts with ground color yellowish brown. Hemelytron comparatively evenly colored, corium obscurely patterned with pale areas at inner angle and along costal margin, and with dark spots apically and along costal margin at one-quarter and two-thirds of distance from base. Membrane with extremely obscure dark pattern consisting of a medial V-shaped mark, a streak along posterior margin of each corium, and a streak on each side from near apex of V running laterally and somewhat posteriorly to lateral margin. Femora and tibiae yellowish brown and unicolored. Antennal segment I yellowish brown with both ends slightly pale, II yellowish brown. Labium yellowish brown with apex dark brown. Length of holotype 3.26.

Holotype male, Papua New Guinea: East Sepik District, Yaibos, 2030-2180 m, VI-11-1963, JS.

Etymology: Exophthalmus, G. for prominent eyes, referring to the stalked eyes.

5. *Bryanellocoris oculatus* Chen & Ashlock, n. sp.

Figs. 4E, 6H

Head strongly deflexed, with anteocular length viewed from above much less than eye length (0.07:0.17); vertex flat between eyes; median sulcus at base of vertex narrow and obscure; head dull textured at posterior dorsal part, subshining at anterior dorsal part and below jugal carina; head length 0.77, width including eyes 0.88; anteocular length 0.39, width of interocular space 0.51; eye moderate in size, stalked, with top higher than vertex, eye length 0.24, width 0.19; labium long, reaching hind coxae or front edge of abdomen, basal segment reaching front edge of prosternum, segment lengths from base 0.53, 0.50, 0.38, 0.31; antennal segment I about 2.5 times as thick at middle as segment II, segment lengths from base 0.41, 1.30, 1.06, 0.93. *Pronotum* with collar impunctate or with sparse fine punctures dorsally; lateral margin of anterior lobe moderately convex, callosity with 8 to 10 punctures in center; humeral angle with dorsal tubercle small and inconspicuous, and laterally directed carina small, rounded apically with anterior margin rounded and posterior margin nearly straight and oblique to longitudinal axis of body; median length of pronotum 0.81, length of anterior lobe plus collar about one-half length of posterior lobe (0.29:0.51), width across collar 0.58, greatest width including humeral carinae 1.17. *Scutellum* with central part of disc without an elevated carina; median length 0.58, width at base 0.58. *Hemelytron* exceeding abdomen by about one-half apical length of membrane; length of corium 1.96, length of claval commissure 0.69, basal length of membrane 0.86, apical length 0.87. *Thorax* ventrally punctate, punctures dense and fine (or sparse and coarse); fore femur armed with 2 bicolored, subapical spines with proximal tubercle of each spine conical and shorter than apical seta. *Color.* Head, collar, anterior lobe and humeral carina of pronotum, venter of thorax except acetabulae and posterior metapleural plate, and basal part of scutellum dark reddish brown, acetabulae and posterior metapleural plate pale; remaining parts with ground color pale yellowish brown. Scutellum with pale median longitudinal stripe and with one pale spot on each side. Hemelytron with pale areas on clavus near apex, and on corium at inner angle and along costal margin, and with dark spots apically and along costal margin at one-quarter and two-thirds of distance from base. Membrane with obscure dark pattern consisting of a medial V-shaped mark, a streak on each side from near apex of V running laterally and somewhat posteriorly to lateral margin, and with a distinct oval whitish spot on either side of midline in middle of anterior half of membrane. Femora and tibiae yellowish brown and unicolored. Antenna yellowish brown, segment I with both ends pale, segments II and III with apex obscurely pale, segment IV dark reddish brown. Labial segment I brown, II and III yellowish brown, apex dark. Length of holotype 3.67.

Holotype male, Indonesia (Irian Jaya): Vogelkop, Bomberi, 700-900 m, VI-6-1959, JLG. *Paratypes,* 1 specimen with abdomen missing, same data as holotype; Papua New Guinea: Morobe District, 1 female, Ulap, 800-1100 m, IX-1968, NLHK.

Etymology: Oculatus, L., pertaining to eyes, which are prominently stalked.

6. *Bryanellocoris cretatus* Chen & Ashlock, n. sp.
Figs. 4F, 7A

Head moderately deflexed, with anteocular length viewed from above less than eye length (0.17:0.26); vertex nearly flat between eyes; median sulcus at base of vertex conspicuous, extending far anterior of level of ocelli; head length 0.86, width including eyes 1.09; anteocular length 0.38, width of interocular space 0.62; eye moderate in size, not stalked, with top higher than vertex, eye length 0.31, width 0.24; labium short, nearly reaching anterior edge of middle coxae, basal segment reaching front edge of prosternum, segment lengths from base 0.65, 0.53, 0.41, 0.34; antenna long, segment I about 3 times as thick at middle as segment II, segment lengths from base 0.92, 2.30, 2.23, 1.61. *Pronotum* with collar impunctate dorsally; lateral margin of anterior lobe strongly convex, callosity with about 10 punctures in center; humeral angle with dorsal tubercle conspicuous and laterally directed carina large, triangular, acute apically with both anterior and posterior margins nearly straight and with posterior margin perpendicular to longitudinal axis of body, carina strongly projecting laterally and obliquely upward and longer laterally than upward projection of humeral tubercle; median length of pronotum 1.34, length of anterior lobe plus collar equal to two-thirds length of posterior lobe (0.53:0.81), width across collar 0.81, greatest width including humeral carinae 2.26. *Scutellum* with elevated central part of disc forming a Y-shaped carina; median length 1.05, width at base 0.87. *Hemelytron* exceeding abdomen by about one-fifth apical length of membrane; length of corium 3.46, length of claval commissure 0.82, basal length of membrane 1.48, apical length 1.34. *Thorax* ventrally with sparse coarse punctures; fore coxa with prominent tubercle or spine over trochanter; fore femur armed with 4 strong, elongate, nearly unicolored spines with proximal tubercle of each spine cylindrical and much longer than apical seta. *Color.* Whole body comparatively dark. Head, collar, anterior lobe and humeral carinae of pronotum, venter of thorax, and basal part of scutellum dark reddish brown; posterior lobe of pronotum pale yellowish brown; apex of scutellum pale, subapical area dark brown; venter of abdomen reddish brown, with longitudinal dark stripe nearly black on each side and with pale yellowish brown stripes along lateral edges. Hemelytron strongly patterned with pale areas on clavus near apex, and on corium at inner angle and apex, each spot within a large dark area, pale along costal margin and with dark spots at one-quarter and two-thirds of distance from base. Membrane with dark pattern consisting of a medial V-shaped mark, a very broad streak on each side from near apex of V running laterally and slightly posteriorly to lateral margin, a streak along posterior margin of corium, and a median T-shaped spot in front of V with a white spot on each side. Femora pale yellowish brown, with subapical band brown, tibiae pale yellowish brown with both apex and subbase darker. Antennal segment I dark yellowish brown with both ends pale, segment II pale yellowish brown with apical three-eighths yellowish white, segment IV dark reddish brown. Labial segment I brown, remaining segments yellowish brown, apex of segment IV dark. Length of holotype 6.41.

Holotype female, NEW BRITAIN: Gazelle Peninsula, Kerawat, 60 m, IX-1-1955, JLG.

Etymology: Cretatus, L. for distinguished, which refers to several distinctive features: the prominent humeral carinae and tubercles, and the strikingly bicolored antennal segment III.

A single female (New Britain, Gazelle Peninsula, Upper Warangai, 1250 m, XII-1 to 4-1962, JS) lacking the distal two antennal segments agrees with the type specimen of *B. cretatus* in having a coxal spine, short labium, and similar body shape including the pronotum, but differs in being paler in coloration and in having the humeral carinae less well developed. While it is possible that the specimen is conspecific with *B. cretatus,* it differs enough that we have thought it best to exclude it until a larger series is available.

7. *Bryanellocoris coxaspinosus* Chen & Ashlock, n. sp.
Fig. 4G

Head strongly deflexed, with anteocular length viewed from above much less than eye length (0.14:0.26); vertex nearly flat between eyes; median sulcus at base of vertex moderately deep, extending anterior to level of ocelli; head length 0.96, width including eyes 1.07, anteocular length 0.41, width of interocular space 0.65; eye moderate in size, not stalked, with top higher than vertex, eye length 0.34, width 0.21; labium short, reaching middle coxae, basal segment reaching front edge of prosternum, segment lengths from base 0.58, 0.53, 0.41, 0.36; antenna very long, about 1.5 times body length including membrane, segment I about 3.5 times as thick at middle as segment II, segment lengths from base 1.08, 3.09, 2.85, 1.20. *Pronotum* with collar impunctate dorsally; lateral margin of anterior lobe strongly convex, callosity with about 30 punctures in center; humeral angle with dorsal tubercle conspicuous and laterally directed carina large and triangular, acute apically with anterior margin slightly curved and posterior margin nearly

straight and slightly oblique to longitudinal axis of body; median length of pronotum 1.35, length of anterior lobe plus collar about equal to length of posterior lobe (0.65:0.70), width across collar 0.79, greatest width including humeral carinae 1.96. *Scutellum* with elevated central part of disc forming a Y-shaped carina; median length 1.01, width at base 0.87. *Hemelytron* exceeding abdomen by about one-quarter apical length of membrane; length of corium 2.98, length of claval commissure 0.70, basal length of membrane 1.27, apical length 1.10. *Thorax* ventrally with sparse coarse punctures; fore coxa with prominent spine over trochanter; fore femur armed with 4 strong, elongate, nearly unicolored spines with proximal tubercle of each spine cylindrical and much longer than apical seta. *Color.* Whole body comparatively dark. Head, collar and anterior lobe of pronotum, venter of thorax except acetabulae and part of posterior metapleural plate, and basal part of scutellum dark reddish brown, acetabulae and part of posterior metapleural plate pale; posterior lobe of pronotum and metapleural plates pale yellowish brown; venter of abdomen brown. Hemelytron with obscure pale areas apically and at inner angle of corium each surrounded by a large pale brown area, additional pale area along costal margin interrupted by pale brown spots at one-quarter and two-thirds of distance from base. Membrane with dark pattern consisting of a medial V-shaped mark, a broad streak on each side from near apex of V running laterally and somewhat posteriorly to lateral margin, a streak along posterior margin of corium, and a T-shaped mark in front of V with a kidney-shaped white spot on each side. Femora yellowish brown, subapical band brown, imprecise but broad, especially on fore and hind femora more than one-half length of femur, tibiae yellowish brown and nearly unmarked. Antennal segment I brown with both ends yellowish white, segments II and III pale yellowish brown, III with apical one-seventh yellowish white, segment IV dark reddish brown. Labial segment I brown, other segments yellowish brown, apex dark. Length of holotype 5.73.

Holotype male, Solomon Islands: Bougainville, Kukugai Village, 150 m, XII-1960, WWB. *Paratype,* Solomon Islands: 1 male, Santa Ysabel, Molao, VI-29-1950, C. W. O'Brien.

Etymology: Coxaspinosus, L. for spiny coxa.

8. *Bryanellocoris hexacanthus* Chen & Ashlock, n. sp.

Figs. 4H, 6A

Head moderately deflexed, with anteocular length viewed from above much less than eye length (0.14:0.25); vertex nearly flat between eyes; median sulcus at base of vertex deep; head length 1.03, width including eyes 1.06; anteocular length 0.45, width of interocular space 0.63; eye large, not stalked, with top higher than vertex, eye length 0.33, width 0.22; labium short, reaching between fore and middle coxae (or front edge of middle coxae), basal segment reaching front edge of prosternum, segment lengths from base 0.58, 0.51, 0.41, 0.34; antenna long, segment I about 3 times as thick at middle as segment II, segment lengths from base 1.00, 2.95, 2.74, 1.41. *Pronotum* with collar impunctate dorsally; lateral margin of anterior lobe strongly convex, callosity with about 30 punctures in center; humeral angle with dorsal tubercle conspicuous and laterally directed carina large and subtriangular, acute apically with anterior margin curved, posterior margin nearly straight and slightly oblique to longitudinal axis of body; median length of pronotum 1.37, length of anterior lobe plus collar equal to length of posterior lobe (0.69:0.69), width across collar 0.79, greatest width including humeral carinae 1.99. *Scutellum* with slightly elevated central part of disc forming an inconspicuous Y-shaped carina with stem obscure; median length 1.10, width at base 1.10. *Hemelytron* exceeding abdomen by about three-fifths apical length of membrane; length of corium 3.26, length of claval commissure 0.69, basal length of membrane 1.37, apical length 1.58. *Thorax* ventrally with sparse punctures, punctures fine on anterior propleural plate, coarse on posterior propleural plate, and fine on meso- and metapleural plate; seta in each puncture much longer than diameter of puncture; fore femur armed with 6 strong, elongate, bicolored spines with proximal tubercle of each spine cylindrical and much longer than apical seta. *Color.* Head, collar and anterior lobe of pronotum, venter of thorax except acetabulae and posterior metapleural plate, and basal part of scutellum reddish brown, acetabulae and posterior metapleural plate pale; remaining parts with ground color pale yellowish brown. Hemelytron with apex of clavus pale and with pale areas apically and at inner angle of corium, each surrounded by a large pale brown spot, additional pale area along costal margin interrupted by pale brown spots at one-quarter and two-thirds of distance from base. Membrane with dark pattern consisting of a medial V-shaped mark, a streak on each side from near apex of V running laterally and somewhat posteriorly to lateral margin, a streak along posterior margin of corium, and a T-shaped mark in front of V with an elongate kidney-shaped white spot on each side. Femora pale yellowish brown, subapical band obscure and light brown on fore femur, relatively distinct

and light brown on middle and hind femur, tibiae pale yellowish brown with both apex and subbase dark. Antennal segments I-III yellowish brown, segment I with both ends pale, II with apex pale, III with apical one-tenth pale, segment IV reddish brown. Labium yellowish brown with apex dark. Length of holotype 6.52.

Holotype male, INDONESIA (IRIAN JAYA): NE Swart Valley, Karubak, 1400-1600 m, XI-9-1958, light trap, JLG. *Paratypes,* 2 males, same data as holotype except XI-9 to 21-1958.

Etymology: Hexacanthus, G. for six spines, as found on the fore femur.

9. *Bryanellocoris incultus* Chen & Ashlock, n. sp.

Head slightly deflexed, with anteocular length viewed from above longer than eye length (0.42:0.28), vertex slightly convex between eyes, median sulcus at base of vertex absent; head length 0.88, width including eyes 1.01, anteocular length 0.42, width of interocular space 0.58, eye moderate in size, not stalked, with top lower than vertex, eye length 0.28, width 0.25, labium exceeding hind coxae and reaching abdominal segment III, basal segment clearly reaching prosternum, segment lengths from base 0.93, 0.97, 0.67, 0.60; antennal segment I about twice as thick at middle as segment II, segment lengths from base 0.87, 1.83, 1.42, 1.42. *Pronotum* with collar finely punctate, lateral margin of anterior lobe slightly convex, callosity with about 8 fine punctures; humeral angle with tubercle small, laterally directed carina small and rounded apically; median length of pronotum 1.17, length of anterior lobe plus collar one-half length of posterior lobe (0.40:0.80), width across collar 0.75, greatest width including humeral carinae 2.05. *Scutellum* with slightly elevated central part of disc forming an inconspicuous Y-shaped carina; median length 1.17, width at base 1.08. *Hemelytron* exceeding abdomen by about one-half apical part of membrane; length of corium 3.57, length of claval commissure 0.75, basal length of membrane 1.58, apical length of membrane 1.38. *Thorax* ventrally with fine punctures except acetabulae and posterior metapleural plate impunctate. Fore femur armed with 2 elongate subapical spines, with proximal tubercle of each spine cylindrical and about twice length of apical seta. *Color.* Head except pale area of tylus, anterior lobe of pronotum, scutellum except pale apex, venter except paler acetabulae and posterior metapleural plate dark reddish brown; collar, posterior lobe of pronotum, stem of scutellar carina yellowish brown; punctures on posterior lobe of pronotum pale reddish brown; posterior lobe of pronotum with dark brown somewhat transverse spot on either side of midline on anterior margin. Hemelytron pale yellowish brown with punctures light reddish brown, obscurely patterned with light reddish brown as follows: spot near claval commissure at level of posterior two-thirds of claval commissure, spot on costal margin at level of basal one-third of membranal margin, triangular area at apex of corium extending one-quarter up membranal margin, incorporating an obscure pale spot. Antenna light reddish brown. Labium light yellowish brown. Legs pale yellowish brown, with broad subapical brown band on femora, narrow subbasal brown band on tibiae. Fore femoral spines with tubercle pale yellowish brown, apical seta reddish brown. Length of holotype 6.5.

Holotype male, PAPUA NEW GUINEA: Morobe District, Sepalakembang, Salawaket Range, 1920 m, light trap, IX-12-1956, EJFJr. Paratypes, 1 male, 1 female, same data as holotype; INDONESIA (IRIAN JAYA): 1 male, Star Mts., Sibil Valley, 1245 m, X-8 to 12-1961, SQ&LQ.

Etymology: Incultus, L. for uncultivated, referring to the relatively undistinguished nature of the species.

10. *Bryanellocoris magnacornis* Chen & Ashlock, n. sp.

Figs. 6B, 8A

Head moderately deflexed, with anteocular length viewed from above shorter than eye length (0.22:0.27); vertex nearly flat between eyes; median sulcus at base of vertex narrow and shallow, slightly exceeding anterior level of ocelli; head length 1.08, width including eyes 1.10; anteocular length 0.50, width of interocular space 0.65; eye large, not stalked, with top higher than vertex, eye length 0.34, width 0.22; labium short, reaching front edge of middle coxae (or between fore and middle coxae), basal segment reaching front edge of prosternum, segment lengths from base 0.58, 0.51, 0.41, 0.41; antenna long, segment I about 3 times as thick at middle as segment II, segment lengths from base 0.99, 2.68, 2.52, 1.54. *Pronotum* with collar impunctate dorsally; lateral margin of anterior lobe strongly convex, callosity with about 30 punctures in center; humeral angle with dorsal tubercle conspicuous and laterally directed carina large and subtriangular, acute apically, with anterior margin curved, posterior margin straight and perpendicular (or slightly oblique) to longitudinal axis of body; median length of pronotum 1.37, length of anterior lobe plus collar equal to length of posterior lobe (0.69:0.69), width across collar 0.81, greatest width including humeral carinae 1.96.

Scutellum with slightly elevated central part of disc forming an inconspicuous Y-shaped carina with median stem obscure; median length 1.06, width at base 0.89. *Hemelytron* exceeding abdomen by about three-fifths apical length of membrane; length of corium 3.29, length of claval commissure 0.72, basal length of membrane 1.51, apical length 1.34. *Thorax* ventrally with sparse punctures, punctures fine on anterior propleural plate, coarse on posterior propleural plate, fine (or coarse) on meso- and metapleural plate; seta in each puncture much longer than diameter of puncture; fore femur armed with 4 strong, elongate, bicolored spines with proximal tubercle of each spine cylindrical and much longer than apical seta. *Color.* Head, collar and anterior lobe of pronotum, venter of thorax except acetabulae and posterior metapleural plate, and basal part of scutellum reddish brown, acetabulae and posterior metapleural plate pale; venter of abdomen yellowish brown (often suffused with dark yellowish brown); remaining parts with ground color pale yellowish brown. Hemelytron patterned with pale areas on clavus near apex, and on corium at inner angle and apex, each within a large light brown area, costal margin pale with dark spots at one-quarter and two-thirds of distance from base. Membrane with dark pattern consisting of a medial V-shaped mark, a streak on each side from near apex of V running laterally and somewhat posteriorly to lateral margin, a streak along posterior margin of corium, and a T-shaped mark in front of V with an elongate irregular white spot on each side. Femora pale yellowish brown and subapical band broad, light brown, and obscure on fore femur, distinct on middle and hind femora, tibiae pale yellowish brown with both apex and subbase dark. Antennal segments I-III yellowish brown, segment I with both ends pale, II with apex pale, III with apical one-tenth pale, segment IV reddish brown. Labium yellowish brown with apex dark. Length of holotype 5.90.

Holotype male, Papua New Guinea: Western Highlands District, Tsenga, upper Jimi Valley, 1200 m, VII-15-1955, JLG. *Paratypes,* Papua New Guinea: Central District (NE), 1 male, Owen Stanley Range, Goilala, Bome, 1950 m, IV-16 to 30-1958, WWB, 1 male, Tapini, 800-1000 m, IX-1968, NLHK; New Ireland: 1 male, Lelet Plateau, Schleinitz Mts., X-1959, WWB.

Etymology: Magnacornis, L. for large horned, referring to the long antennae.

11. *Bryanellocoris globosus* Chen & Ashlock, n. sp.

Fig. 4I

Head strongly deflexed, with anteocular length viewed from above much shorter than eye length (0.10:0.24); vertex flat between eyes; median sulcus at base of vertex narrow, obscure; head length 0.87, width including eyes 1.01, anteocular length 0.43, width of interocular space 0.58; eye large, not stalked, with top higher than vertex, eye length 0.31, width 0.21; labium short, reaching middle coxae, basal segment reaching front edge of prosternum, segment lengths from base 0.58, 0.51, 0.41, 0.34; antenna long, segment I about 3 times as thick at middle as segment II, segment lengths from base 0.75, 1.96, 1.72, 1.22. *Pronotum* with collar impunctate dorsally; lateral margin of anterior lobe strongly convex, callosity with about 15 to 20 punctures in center; humeral angle with dorsal tubercle moderately conspicuous and laterally directed carina small, acute apically with anterior margin curved and posterior margin nearly straight and oblique to longitudinal axis of body; median length of pronotum 1.17, length of anterior lobe plus collar subequal to length of posterior lobe (0.55:0.62); width across collar 0.74, greatest width including carinae 1.68. *Scutellum* with slightly elevated central part of disc forming an inconspicuous Y-shaped carina; median length 0.87, width at base 0.84. *Hemelytron* exceeding abdomen by about two-fifths apical length of membrane; length of corium 2.74, length of claval commissure 0.62, basal length of membrane 1.23, apical length 1.17. *Thorax* with posterior of propleural plate and anterior of metapleural plate ventrally having sparse and coarse punctures, mesopleura sparsely punctate, anterior of propleural plate nearly impunctate except for several sparse scattered punctures; fore femur armed with 4 (or 5) strong, elongate, nearly unicolored spines with proximal tubercle of each spine cylindrical and longer than apical seta. *Color.* Head, collar and anterior lobe of pronotum, venter of abdomen except acetabulae and posterior metapleural plate, and base of scutellum dark reddish brown, acetabulae and posterior metapleural plate pale; remaining parts with ground color yellowish brown. Hemelytron patterned with pale areas on clavus near apex, and on corium apically and at inner angle, each within a large light brown area, costal margin pale with dark spots at one-quarter and two-thirds of distance from base. Membrane with dark pattern consisting of a medial V-shaped mark, a broad streak on each side from near apex of V running laterally and posteriorly to lateral margin, a streak along posterior margin of corium, and a T-shaped mark in front of V with a kidney-shaped white spot on each side. Femora yellowish brown, subapical band light brown, obscure on fore femur and relatively distinct on middle and hind femur, tibiae yellowish brown

with both apex and subbase slightly darker. Antennal segment I pale yellowish brown with both ends pale, II and III pale yellowish brown, III with apical one-eighth yellowish white, segment IV reddish brown. Labium yellowish brown with apex dark. Length of holotype 5.21.

Holotype male, SABAH (N. BORNEO): W coast Residency, Ranau, 8 mi. N Paring Hot Spring, 500 m, X-8 to 11-1958, sweeping, T. C. Maa. *Paratype,* 1 male, SABAH (N. BORNEO): Tawau, Quoin Hill, VIII-15 to 20-1962, light trap, H. Holtmann.

Etymology: Globosus, L. for spherical, referring to the shape of the anterior pronotal lobe.

12. *Bryanellocoris humeralis* Chen & Ashlock, n. sp.

Fig. 4J

Head moderately deflexed, with anteocular length viewed from above less than eye length (0.21:0.24); vertex flat between eyes; median sulcus at base of vertex narrow, moderately deep (or shallow), extending anterior to level of ocelli; head length 0.86, width including eyes 0.99; anteocular length 0.41, width of interocular space 0.58; eye moderate in size, not stalked, with top higher than vertex, eye length 0.31, width 0.21; labium short, reaching middle coxae, basal segment reaching or not reaching front edge of prosternum, segment lengths from base 0.55, 0.53, 0.39, 0.36; antenna long, segment I about twice as thick at middle as second segment, segment lengths from base 0.69, 1.78, 1.44, 1.23. *Pronotum* with collar impunctate dorsally; lateral margin of anterior lobe strongly convex, callosity with about 15 punctures in center; humeral angle with dorsal tubercle conspicuous and with laterally directed carina large, acute apically with anterior margin curved and posterior margin nearly straight and perpendicular (or slightly oblique) to longitudinal axis of body; median length of pronotum 1.06, length of anterior lobe plus collar about equal to (or less than) two-thirds length of posterior lobe (0.41:0.65); width across collar 0.75, greatest width including humeral carinae 1.83. *Scutellum* with slightly elevated central part of disc forming an inconspicuous Y-shaped carina; median length 0.93, width at base 0.96. *Hemelytron* exceeding abdomen by about one-third apical length of membrane; length of corium 2.78, length of claval commissure 0.62, basal length of membrane 1.27, apical length 1.13. *Thorax* ventrally with sparse, coarse punctures, seta in each puncture much longer than puncture diameter; fore femur armed with 3 (rarely 4) elongate, bicolored spines with proximal tubercle of each spine cylindrical and longer than apical seta. *Color.* Head, collar and anterior lobe of pronotum, basal one-half and apical third of scutellum, and venter of thorax except acetabulae and posterior metapleural plate dark reddish brown, acetabulae and posterior metapleural plate pale; remaining parts with ground color pale yellowish brown. Hemelytron patterned with pale areas near apex of clavus and on corium apically and at inner angle, each pale area surrounded by a large light brown area, costal margin pale with dark spots at one-quarter and two-thirds of distance from base. Membrane with dark pattern consisting of a medial V-shaped mark, a broad streak on each side from near apex of V running laterally and posteriorly to lateral margin, a streak along posterior margin of corium, and a T-shaped dark spot in front of V with a white oval spot on each side. Femora pale yellowish brown with subapical band conspicuous and brown, tibiae pale yellowish brown and unmarked. Antennal segments I-III yellowish brown, segment I with both ends pale, III with apical one-sixth white or yellowish white, segment IV dark reddish brown. Labium pale yellowish brown with apex dark. Length of holotype 4.97.

Holotype female, SOLOMON ISLANDS: Guadalcanal, Gold Ridge Suta (Jonapua), 1100 m, V-26-1956, JLG. *Paratypes,* PAPUA NEW GUINEA: Milne Bay District, 1 female, Woodlark Is. (Murua), Kulumadau Hill, IV-16 to 22-1957, WWB; Morobe District, 1 female, Mt. Kaindi, 2360 m, XI-19 to 20-1957, light trap, WCG, 1 female, Wau, 1200 m, II-16-1962, light trap, JS, 1 female, Wau, Bulolo River, 850 m, VIII-24-1965, JS, 1 female, Mt. Shungol, 1250 m, V-31-1967, Mena (native collector); Western Highlands District, 1 female, Tsenga, upper Jimi Valley, 1200 m, VI-15-1956, JLG.

Etymology: Humeralis, L., pertaining to the shoulder, referring to the prominent humeral carina and tubercle that distinguish this species.

13. *Bryanellocoris hebridensis* Chen & Ashlock, n. sp.

Head strongly deflexed, with anteocular length viewed from above less than eye length (0.17:0.22); vertex flat between eyes; median sulcus at base of vertex shallow (or moderately deep), extending anterior to level of ocelli; head length 0.84, width including eyes 0.94; anteocular length 0.38, width of interocular space 0.57; eye moderate in size, not stalked, with top higher than vertex, eye length 0.33, width 0.20; labium short, reaching middle coxae, basal segment reaching about to front edge of prosternum, segment lengths from base 0.57, 0.50, 0.41, 0.34; antenna long, segment I about twice as thick at

middle as segment II, segment lengths from base 0.69, 1.58, 1.20, 1.33. *Pronotum* with collar impunctate dorsally; lateral margin of anterior lobe strongly convex, callosity with about 10 punctures in center; humeral angle with dorsal tubercle conspicuous and laterally directed carina large, acute apically with anterior margin curved and posterior margin nearly straight and slightly oblique (or perpendicular) to longitudinal axis of body; median length of pronotum 1.01, anterior lobe plus collar about two-thirds length of posterior lobe (0.39:0.62), width across collar 0.75, greatest width including humeral carinae 1.82. *Scutellum* with slightly elevated central part of disc forming an inconspicuous Y-shaped carina; median length 0.93, width at base 0.89. *Hemelytron* exceeding abdomen by about two-fifths apical length of membrane; length of corium 2.81, length of claval commissure 0.65, basal length of membrane 1.23, apical length 1.15. *Thorax* ventrally with sparse, coarse punctures, seta in each puncture longer than diameter of puncture; fore femur armed with 3 (or 2-4) moderate sized, bicolored or nearly unicolored spines with proximal tubercle of each spine cylindrical and longer than apical seta. *Color.* Head, collar and anterior lobe of pronotum, basal one-half and apical one-third of scutellum, and venter of thorax except acetabulae and posterior metapleural plate dark reddish brown, acetabulae and posterior metapleural plate pale; remaining parts with ground color pale yellowish brown. Hemelytron patterned with pale areas on clavus near apex and on corium apically and at inner angle, each pale area surrounded by a large pale brown spot, costal margin pale with dark spots at one-quarter and two-thirds of distance from base. Membrane with dark pattern consisting of a medial V-shaped mark, a broad streak on each side from near apex of V running laterally and posteriorly to lateral margin, a streak along posterior margin of corium, and a pair of spots in front of V meeting on midline, each with a small white spot in it. Femora pale yellowish brown, subapical band very obscure and light brown, tibiae pale yellowish brown and unmarked. Antennal segments I-III yellowish brown, segment I with basal end obscurely pale, III with apical one-seventh slightly pale, IV dark reddish brown. Labium pale yellowish brown with apex dark. Length of holotype 5.15.

Holotype female, New Hebrides: SW Espiritu Santo Is., Namatasopa, 300 m, VIII-28-1957, light trap, JLG. *Paratypes,* 14 males, 16 females, 1 without abdomen, same data as holotype but VIII-29-1957.

Etymology: Hebridensis, from the New Hebrides.

A specimen from New Guinea (1 female, West Irian, Wissolineren, Kamo-Debei division, 1700 m, VIII-13-1955, JLG) is very similar to *B. hebridensis.* It is missing one hemelytron and the antennae beyond a part of segment II. Although we cannot find significant differences, we feel it better to have more specimens available before formally recording this species from New Guinea. A seemingly typical female, however, is labeled Sabah (N. Borneo) (Tenompok, 30 mi. E Jessetten, 1460 m, II-19-59, T.C. Maa).

14. *Bryanellocoris pilosus* Chen & Ashlock, n. sp.

Figs. 2, 3B, 6D

Head moderately deflexed, with anteocular length viewed from above about equal to eye length (0.17:0.18); vertex convex between eyes; appressed pubescence short and sparse on both dorsal and ventral surfaces and with sparse, scattered, long, erect hairs dorsally; base of vertex without median sulcus; head length 0.79, width including eyes 0.77, anteocular length 0.41, width of interocular space 0.45; eye moderate in size, not stalked, with top lower than vertex, eye length 0.21, width 0.16; labium reaching front edge of hind coxae, basal segment not quite reaching prosternum, segment lengths from base 0.55, 0.55, 0.46, 0.34; antenna long, segment I densely covered with moderately long, erect hairs, erect hairs dark and thick, longer than greatest width of segment, segments II and III with sparse, dark, short, erect hairs, segment IV with pale and short appressed pubescence, segment I about 3.5 times as thick at middle as segment II, segment IV very slightly thickened, segment lengths from base 0.81, 1.37, 1.03, 1.22. *Pronotum* with sparse, scattered, long, erect hairs arising from between punctures on collar, anterior lobe, and anterior part of posterior lobe, seta in each puncture shorter than diameter of puncture; collar nearly impunctate dorsally; lateral margin of anterior lobe slightly convex, callosity nearly impunctate with 4 or 5 punctures in center; humeral angle with dorsal tubercle moderate in size and laterally directed carina small, triangular, acute apically with both anterior and posterior margins straight, oblique to longitudinal axis of body, and nearly equal in length; median length of pronotum 0.91, length of anterior lobe plus collar slightly more than one-half length of posterior lobe (0.33:0.58), width across collar 0.58, greatest width including humeral carinae 1.39. *Scutellum* with sparse, scattered, long, erect hairs arising from between punctures; elevated central part of disc forming a Y-shaped carina; median length 0.65, width at base 0.65.

Hemelytron comparatively dull, with sparse, scattered, long, erect hairs arising from between punctures; membrane exceeding abdomen by one-half apical length; length of corium 2.30, length of claval commissure 0.51, basal length of membrane 1.13, apical length 1.03. *Thorax* ventrally with sparse punctures, seta in each puncture much longer than diameter of puncture; fore femur armed with 2 moderate-sized, unicolored, subapical spines, spines set close together, distance between spines about one-half distance between apex and distal subapical spine, proximal tubercle of each spine slightly longer than apical seta. *Color.* Head, collar, anterior lobe and humeral carinae of pronotum, scutellum except apex, venter of thorax, and abdomen except apex, lateral edges, and posterior metapleural plate dark, nearly blackish brown, apex and lateral edges of abdomen and posterior metapleural plate pale, scutellar apex pale yellowish brown; remaining parts with ground color pale yellowish brown. Hemelytron patterned with obscure pale areas at inner angle and along costal margin, and with dark spots apically and along costal margin two-thirds of distance from base. Membrane with obscure dark pattern consisting of a medial V-shaped mark, a streak on each side from near apex of V running laterally and posteriorly to lateral margin, and a streak along posterior margin of corium. Femora pale yellowish brown with subapical band obscure and light brown, tibiae pale yellowish brown with both apex and subbase slightly darker. Antennal segment I brown, II and III pale yellowish brown, segment IV brown with proximal one-fifth yellow. Labium pale yellowish brown with apex dark. Length of holotype 4.66.

Holotype female, JAVA (western): Tjibodas, VII-22-1965, J. Winkler. *Paratype,* 1 female, same data as holotype but VIII-2 1965.

Etymology: Pilosus, L. for hairy, referring to the overall pilosity and especially that of the first antennal segment.

A third specimen from Java (Tgio, IX-25-1960, JLG) is similar in its relatively elongate body shape, rostral length, femoral spines, and in the extent of the humeral carina, but differs in having the head, anterior lobe of the pronotum, the scutellum, and the thorax ventrally reddish brown instead of nearly black. The hairs of the first antennal segment are shorter and are suberect. Although certainly closely related to *B. pilosus,* this specimen differs too much from that species to stand as a paratype.

15. *Bryanellocoris longicornis* (China)

Figs. 5A, 6J

Bryanella longicornis China, 1930: 136-137.

Bryanellocoris longicornis; Slater, 1964: 1044.

Head slightly deflexed, with anteocular length viewed from above slightly longer than eye length (0.24:0.22); vertex convex between eyes; pubescence short and sparse on both dorsal and ventral surfaces and with sparse, scattered, long, erect hairs dorsally; median sulcus at base of vertex deep; head length 0.79, width including eyes 0.89; anteocular length 0.39, width of interocular space 0.53; eye moderate in size, not stalked, with top lower than vertex, eye length 0.27, width 0.18; labium reaching middle (or hind) coxae, basal segment reaching front edge of prosternum, segment lengths from base 0.55, 0.45, 0.39, 0.34; antenna long, segment I about twice as thick at middle as segment II, segment lengths from base 0.65, 1.53, 1.06, 1.03. *Pronotum* with sparse, scattered, long, erect hairs arising from punctures and moderately long erect hairs along lateral margins; collar nearly impunctate dorsally; lateral margin of anterior lobe slightly convex, callosity with 8 to 10 punctures in center; humeral angle with dorsal tubercle moderate in size and laterally directed carina small, acute apically with anterior margin long and curved and posterior margin short, straight, and slightly oblique (or perpendicular) to longitudinal axis of body; median length of pronotum 0.89, length of anterior lobe plus collar about two-thirds length of posterior lobe (0.34:0.55), width across collar 0.72, greatest width including humeral carinae 1.65. *Scutellum* with sparse, scattered, long, erect hairs arising from punctures; elevated central part of disc forming a Y-shaped carina; median length 0.79, width at base 0.79. *Hemelytron* with sparse, scattered, long, erect hairs arising from punctures on clavus and corium; membrane exceeding abdomen by one-half apical length, length of corium 2.40, length of claval commissure 0.51, basal length of membrane 1.10, apical length 0.79. *Thorax* ventrally with sparse, coarse punctures, seta in each puncture longer than diameter of puncture; fore femur armed with at most 1 weak subapical spine (but described as 'unarmed' by China, 1930), spine unicolored, with proximal tubercle conical and much shorter than apical seta. *Color.* Head, anterior lobe of pronotum, scutellum except apex, venter of thorax except acetabulae and posterior metapleural plate, and abdomen dark reddish brown, scutellar apex, acetabulae, and posterior metapleural plate pale; remaining parts with ground color pale yellowish brown. Hemelytron patterned with obscure pale areas at inner angle (sometimes surrounded by an obscure large dark spot), and along costal margin, and with dark spots apically, along costal margin at two-thirds of distance from base (and sometimes at apical one-

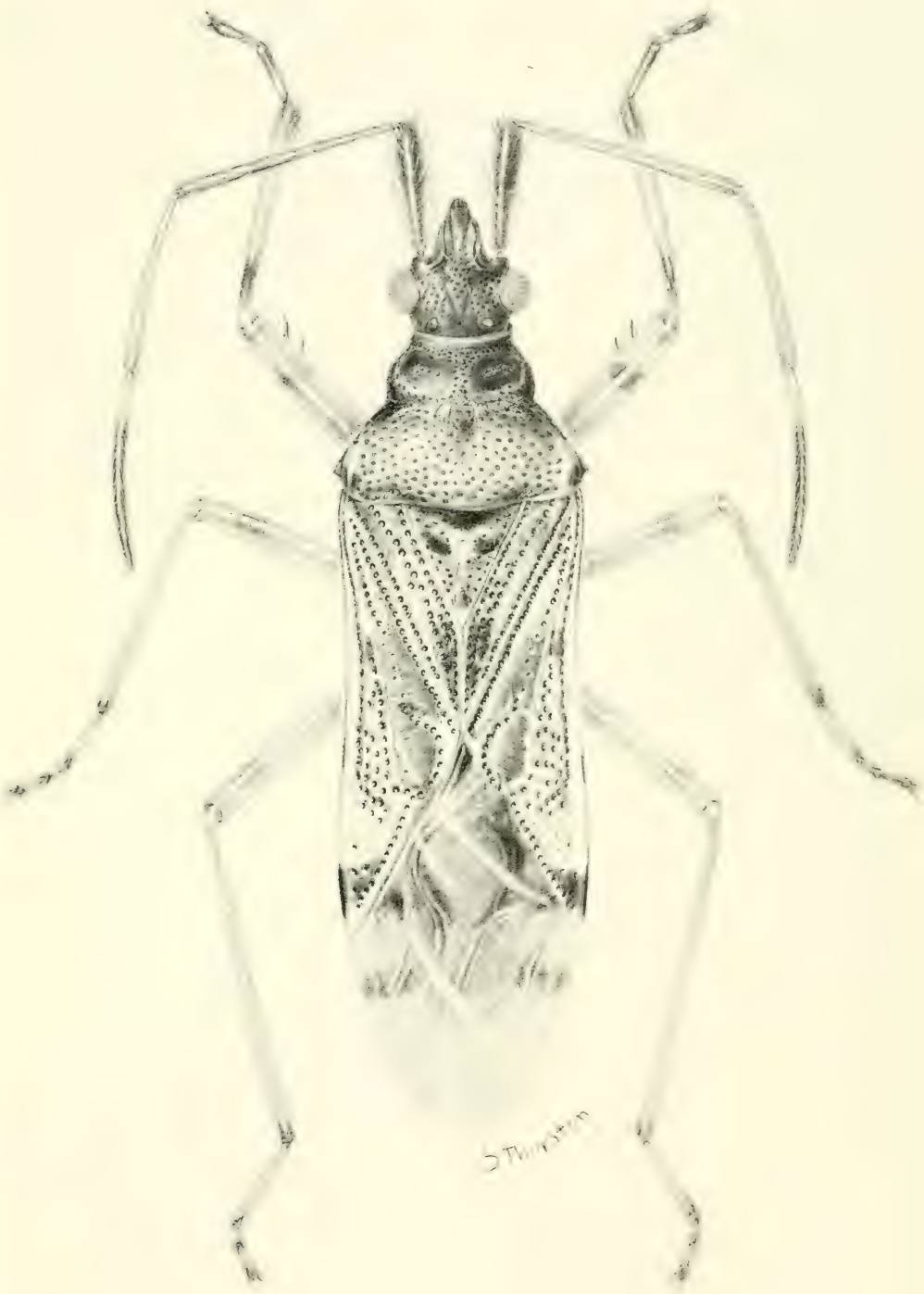

FIG. 2. Dorsal view of paratype of *Bryanellocoris pilosus*.

third of clavus). Membrane with obscure dark pattern consisting of a medial V-shaped mark, a streak on each side from near apex of V running laterally and posteriorly to lateral margin, and a streak along posterior margin of corium. Femora pale yellowish brown, nearly unicolored (or sometimes with subapical band slightly dark), tibiae pale yellowish brown with both apex and subbase obscurely darker. Antennal segments I-III pale yellowish brown, segment IV reddish brown. Labium yellowish brown with apex dark. Length of redescribed female 4.39.

The description is based on a female from SAMOA: Tutuita, Mt. Olotele, 512 m, II-15-1965, sweeping, GAS. Other material. SAMOA: 1 male, same data as redescribed specimen; 1 male, Savaii, Safune, lowland to 1000 m, V-1-1924, EHBJr; 1 male, 1 immature, Savaii, Safune, 2000-4000 m, rain forest, V-9-1924, EHBJr; 1 male, 1 female, Savaii, Salailua, V-21 to 22-1924, EHBJr; 2 females, Upolu, Afaimalu, 670 m, VII-5-1940, E. C. Zimmerman, VI-14-1940, O. H. Swezey; 1 female, Upolu, Malololelei, II-1955, NLHK. The holotype and paratypes are in the Bishop Museum, Honolulu, Hawaii.

16. *Bryanellocoris fijiensis* Chen & Ashlock, n. sp.

Figs. 5D, 7B

Head moderately deflexed, with anteocular length viewed from above less than eye length (0.14:0.18); vertex nearly flat between eyes; median sulcus at base of vertex conspicuous, forming a deep and broad pit; dorsal surface of head with basal one-half dull textured, anterior one-half and venter subshining; head length 0.93, width including eyes 0.97; anteocular length 0.39, width of interocular space 0.56; eye moderate in size, not stalked, with top higher than vertex, eye length 0.33, width 0.21; labium short, reaching to between fore and middle coxae, basal segment not reaching prosternum, segment lengths from base 0.89, 0.29, 0.31, 0.38; antenna long, segment I twice as thick at middle as segment II, segment lengths from base 0.82, 1.61, 1.13, 1.41. *Pronotum* with sparse, scattered, long, erect hairs on anterior lobe and moderately long, erect hairs on posterior lobe arising from between punctures in addition to appressed short seta in each puncture; collar subshining, impunctate dorsally; lateral margin of anterior lobe moderately convex, callosity with about 8 to 12 fine punctures in center; humeral angle with dorsal tubercle moderate in size and with laterally directed carina large, subtriangular, acute apically with anterior margin curved, posterior margin straight, oblique to longitudinal axis of body; median length of pronotum 1.10, length of anterior lobe plus collar subequal to two-thirds length of posterior lobe (0.41:0.69), width across collar 0.72, greatest width including humeral carinae 1.96. *Scutellum* with a few sparse, scattered, moderately long, erect hairs arising from between punctures; elevated central part of disc forming a thick Y-shaped carina; median length 0.97, width at base 0.96. *Hemelytron* exceeding abdomen by about one-third apical length of membrane; length of corium 2.92, length of claval commissure 0.62, basal length of membrane 1.30, apical length 1.10. *Thorax* ventrally with sparse, coarse punctures; fore femur armed with 2 strong, elongate, bicolored, subapical spines with proximal tubercle cylindrical and longer than apical seta; ventral side of hind femur usually with a very fine, long, simple, subapical seta. *Color.* Head except tylus, anterior lobe of pronotum, basal half of scutellum, venter of thorax except acetabulae and posterior metapleural plate, and abdomen reddish brown, tylus, acetabulae, and posterior metapleural plate pale; remaining parts with ground color pale yellowish brown. Hemelytron with conspicuous pale areas on corium at inner angle and along costal margin, and with dark spots apically along costal margin at two-thirds of distance from base, at inner angle surrounding pale spot, and on apical one-third of clavus. Membrane with dark pattern consisting of a medial V-shaped mark, a broad streak on each side from near apex of V running laterally and posteriorly to lateral margin, a streak along posterior margin of corium, and a median spot in front of V. Femora pale yellowish brown, with subapical band conspicuous and dark brown, base of fore femur with narrow brown band, tibiae pale yellowish brown with both apex and subbase slightly darker. Antennal segment I yellowish brown with basal one-third pale, II and III pale yellowish brown, segment IV brown. Labium yellowish brown with apex dark. Length of holotype 5.42.

Holotype female, FIJI: Viti Levu, Nadarivatu, 850 m, III-8 to 13-1963, C. M. Yoshimoto. *Paratype,* FIJI: 1 female, Mt. Victoria, 600-1000 m, VII-30-1967, JMS.

Etymology: Fijiensis, from Fiji.

17. *Bryanellocoris strongylus* Chen & Ashlock, n. sp.

Head moderately deflexed, with anteocular length viewed from above about equal to eye length (0.14:0.14); vertex nearly flat between eyes; median sulcus at base of vertex conspicuous, forming a deep pit, exceeding anterior level of ocelli; head length 0.72, width including eyes

0.82; anteocular length 0.34, width of interocular space 0.51; eye relatively small, not stalked, with top higher than vertex, eye length 0.21, width 0.15; labium reaching midway between middle and hind coxae, basal segment not quite reaching prosternum, segment lengths from base 0.45, 0.45, 0.57, 0.33; antennal segment I about twice as thick at middle as segment II, segment lengths

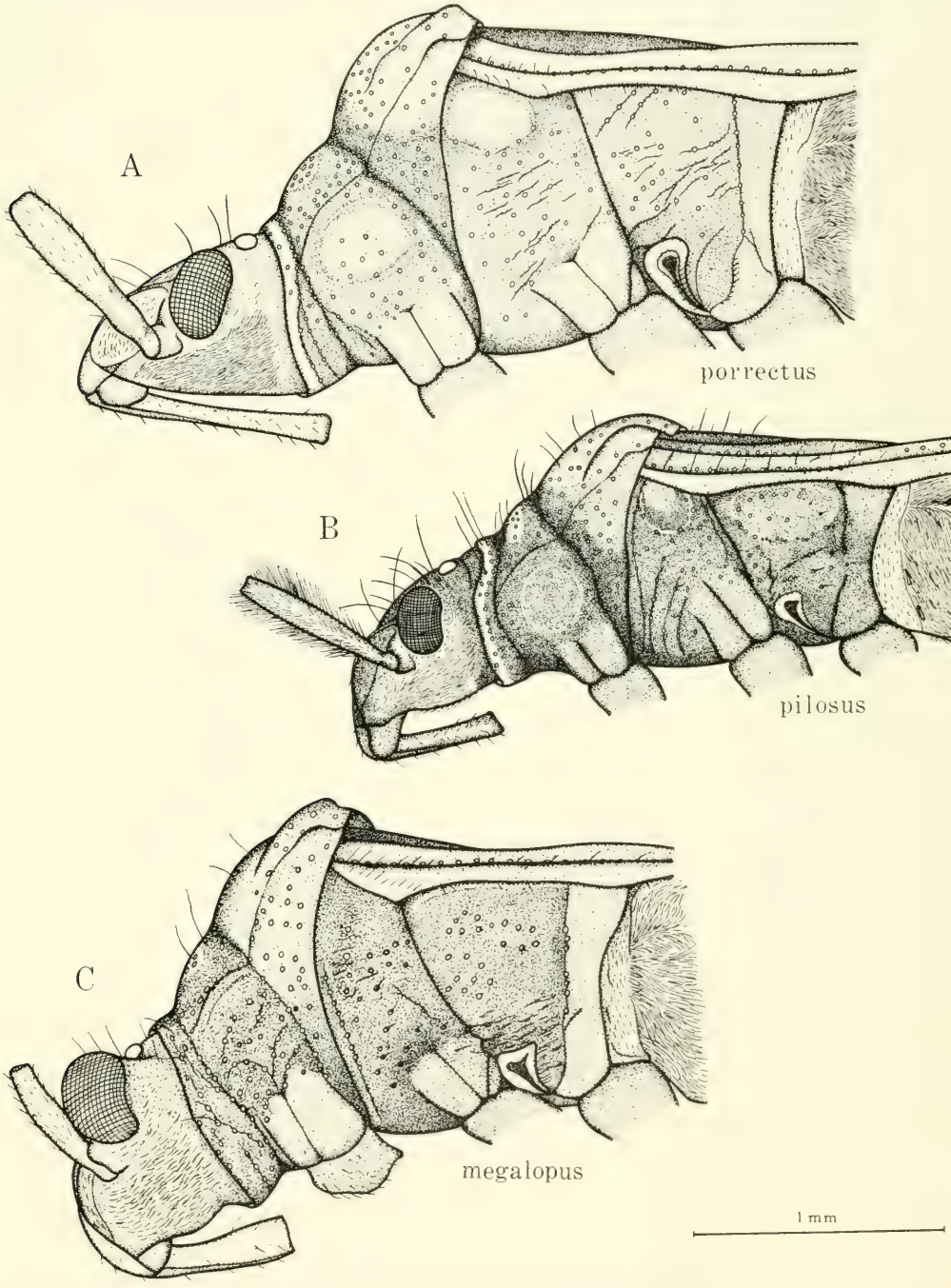

FIG. 3. Lateral views of heads and thoraces of named species of *Bryanellocoris*.

from base 0.60, 1.37, 1.23, 0.96. *Pronotum* with collar finely punctate; lateral margin of anterior lobe of pronotum slightly convex, callosity with about 10 to 12 fine punctures in center; humeral angle with dorsal tubercle inconspicuous and laterally directed carina small or moderate in size, rounded (or slightly acute) apically; median length of pronotum 0.91, length of anterior lobe plus collar slightly more than one-half length of posterior lobe (0.33:0.58), width across collar 0.65, greatest width including humeral carinae 1.49. *Scutellum* with slightly elevated central part of disc forming an inconspicuous Y-shaped carina; median length 0.69, width at base 0.72. *Hemelytron* exceeding abdomen by about one-half to two-thirds apical length of membrane; length of corium 2.37, length of claval commissure 0.55, basal length of membrane 1.13, apical length 1.03. *Thorax* ventrally with fine punctures; fore femur armed with 2 elongate, slightly bicolored, subapical spines with proximal tubercle of each spine cylindrical and about as long as apical seta. *Color.* Head, collar and anterior lobe of pronotum, basal two-thirds of scutellum, and venter of thorax except posterior metapleural plate dark reddish brown with dense white pruinosity, posterior metapleural plate pale; posterior lobe of pronotum yellowish brown; remaining parts with ground color pale yellowish brown. Hemelytron evenly colored, patterned with obscure pale areas at inner angle and along costal margin, and with dark spots apically and along costal margin at two-thirds of distance from base. Membrane with obscure dark pattern consisting of a medial V-shaped mark, a streak on each side from near apex of V running laterally and posteriorly to lateral margin, and streak along posterior margin of corium. Femora and tibiae pale yellowish brown and unicolored. Antennal segments I-III pale yellowish brown, segment I with both ends pale, II with apex slightly dark, III with apex slightly pale, segment IV dark reddish brown. Labium pale yellowish brown with apex dark. Length of holotype 4.46.

Holotype male, PAPUA NEW GUINEA: Morobe District, Wau, 1200 m, VI-28 to 30-1962, JS. *Paratypes,* PAPUA NEW GUINEA: Eastern Highlands District, 1 female, Moife, 15 km NW Okapa, 2100 m, X-11 to 13-1959, T. C. Maa; Morobe District, 1 male, Wau, 1200 m, X-15-1965, Malaise trap, JMS.

Etymology: Strongylus, G. for rounded, referring to the rounded humeral carina.

On hand is a single badly damaged male that seems similar to this species, but it is from Viet Nam (Blao Balao, 500 m, X-14 to 21-1960, C. M. Yoshimoto). Because of its poor condition and distant origin, this specimen is excluded from the type series.

18. *Bryanellocoris micrommatus* Chen & Ashlock, n. sp.

Fig. 6E

Head strongly deflexed, with anteocular length viewed from above slightly less than eye length (0.09:0.11); vertex flat between eyes; median sulcus at base of vertex deep; head length 0.72, width including eyes 0.82; anteocular length 0.38, width of interocular space 0.51; eye small, prominent, nearly stalked, projecting laterally, with top higher than vertex, eye length 0.20, width 0.15; labium long, reaching hind coxae, basal segment reaching to front edge of prosternum, segment lengths from base 0.53, 0.50, 0.38, 0.34; antennal segment I about 3 times as thick at middle as segment II, segment lengths from base 0.33, 1.12, segments III and IV missing. *Pronotum* with collar having fine shallow punctures; lateral margin of anterior lobe slightly convex, callosity with about 8 obscure punctures in center; humeral angle with dorsal tubercle conspicuous and with laterally directed carina moderate in size, acute apically with anterior margin curved and posterior margin straight and oblique to longitudinal axis of body; median length of pronotum 0.79, length of anterior lobe plus collar subequal to one-half length of posterior lobe (0.24:0.55); width across collar 0.63, greatest width including humeral carinae 1.37. *Scutellum* with central part of disc without an elevated carina; median length 0.69, width at base 0.65. *Hemelytron* exceeding abdomen by about one-half apical length of membrane; length of corium 2.09, length of claval commissure 0.41, basal length of membrane 0.96, apical length 0.89. *Thorax* ventrally with small or fine punctures; fore femur armed with 2 elongate, nearly unicolored, subapical spines with proximal tubercle of each spine cylindrical and shorter than apical seta. *Color.* Head, collar and anterior lobe of pronotum, basal one-third of scutellum, venter of thorax except posterior metapleural plate dark reddish brown, nearly blackish brown, posterior metapleural plate pale; apical two-thirds of scutellum reddish brown, remaining parts with ground color yellowish brown. Hemelytron with pale areas on clavus near apex and on corium at inner angle, each surrounded by a large light brown area, and pale along costal margin, and with dark spots apically and along costal margin at two-thirds of distance from base. Membrane with obscure pattern consisting of a medial V-shaped mark, a streak on each side from near apex of V running laterally and posteriorly to lateral mar-

gin, and a streak along posterior margin of corium. Femora and tibiae yellowish brown and unicolored. Antennal segments I and II yellowish brown, segment I with apex slightly pale, II with apex dark. Labium yellowish brown with apex dark. Length of holotype 3.74.

Holotype male, Papua New Guinea: Eastern Highlands District, Moife, 2100 m, X-7 to 14-1959, T. C. Maa.

Etymology: Micrommatus, G. for small eye.

19. *Bryanellocoris orientalis* Hidaka
Fig. 5B

Bryanellocoris orientalis Hidaka, 1962: 166-168.
Bryanellocoris orientalis; Zheng and Zou in Hsiao, 1981: 151-152.

Head strongly deflexed, with anteocular length viewed from above much less than eye length (0.10:0.17); vertex slightly convex between eyes; median sulcus at base of vertex obscure (or absent); head length 0.72, width including eyes 0.82; anteocular length 0.34, width of interocular space 0.50; eye moderate in size, not stalked, with top as high as vertex, eye length 0.26, width 0.16; labium short, reaching middle coxae, basal segment reaching front edge of prosternum, segment lengths from base 0.55, 0.34, 0.27, 0.31; antenna short, segment I about 1.5 times as thick at middle as segment II, segment lengths from base 0.50, 0.82, 0.55, 0.89. *Pronotum* with collar having sparse, small, shallow punctures; lateral margin of anterior lobe moderately convex and with sparse long hairs, callosity with about 8 to 10 fine shallow punctures in center; lateral margin of anterior lobe of pronotum slightly convex; humeral angle with dorsal tubercle inconspicuous and lateral carina very narrow, blunt, and rounded; median length of pronotum 1.10, length of anterior lobe plus collar about equal to one-half length of posterior lobe (0.38:0.72), width across collar 0.69, greatest width 1.42. *Scutellum* with elevated central part of disc forming a conspicuous, thick, Y-shaped carina; median length 0.81, width at base 0.79. *Hemelytron* exceeding abdomen by about one-third or less apical length of membrane; length of corium 2.33, length of claval commissure 0.69, basal length of membrane 0.99, apical length 0.99. *Thorax* ventrally with sparse, small punctures; fore femur armed with 2 weak, unicolored, subapical spines, distal subapical spine with proximal tubercle conical (or cylindrical) and slightly shorter than apical seta, second spine with tubercle conical, small, much shorter than seta. *Color.* Head, anterior lobe of pronotum, venter of thorax except acetabulae and posterior metapleural plate, and base of scutellum dark reddish brown, acetabulae and posterior metapleural plate pale; apical portion of scutellum brown with apex pale yellow and stem of (or whole) Y-shaped carina pale; venter of abdomen brown; remaining parts with ground color yellowish brown. Hemelytron contrastingly patterned with pale areas near apex and at inner angle, each within a large pale brown area, and along costal margin, and with dark spots along costal margin one-quarter and two-thirds of distance from base. Membrane with obscure dark pattern consisting of a medial V-shaped mark, a streak on each side from near apex of V running laterally and somewhat posteriorly to lateral margin, and a streak along posterior margin of corium. Femora yellowish brown (or pale yellowish brown) with subapical band light brown (or brown) and imprecise, tibiae yellowish brown with subbase and apex slightly dark. Antennal segments I-III pale yellowish brown, segment IV dark reddish brown with basal one-fifth to one-quarter pale yellowish brown. Labium yellowish brown with apex dark. Length of redescribed female 4.36.

The description is based on a female from China: Fujian (Fukien), Shaowu, Tachulan, 1000 m, X-27-1942, T. C. Maa. Other material. China: 6 males, 6 females, same data as redescribed specimen; 1 female, Taiwan, Hori (Puli), 750 m, VIII-22-1947, JLG; 1 male, Taiwan, Wulai Kueishan, 300-500 m, XI-11-1957, T. C. Maa. Japan: 1 female, Ryukyus, N Okinawa, Ohisuka, IX-2-1945, JLG; 1 male, 2 females, Ryukyus, Ishigaki, I-5-1955, XI-20 to 30-1952, G. E. Bohart; 1 male, Mt. Rokko, near Kobe, IX-30-1952, E. Nakanishi; 1 female, Honshu, Kanagawa Prefecture, Yugawara, V-2-1955, K. Kawashima.

Hidaka's (1962) male holotype is from Hachijo Island, Tokyo Prefecture, Japan, and is deposited in the Entomological Laboratory, Kyushu University, Fukuoka, Japan. Paratypes are from Honshu, Kyushu, and the Ryukyus, Japan, and from Taiwan and Hubei (Lichuang shui shan ba), China. Zheng and Zou (1981) reported the species from the following provinces of China: Jiangxi (Lu Shan), Sichuan (Emei Shan, the westernmost locality for the species), Guangdong (Qujiang), and Guangxi (Longsheng). *Bryanellocoris orientalis* Hidaka is by far the most widespread species in the genus.

20. *Bryanellocoris spinulus* Chen & Ashlock, n. sp.
Fig. 5E

Head moderately deflexed, with anteocular length viewed from above shorter than eye length (0.19:0.22); vertex flat between eyes; median

sulcus at base of vertex obscure; head length 0.72, width including eyes 0.91; anteocular length 0.31, width of interocular space 0.55; eye large, not stalked, with top much higher than vertex, eye length 0.27, width 0.18; labium short, reaching middle coxae, basal segment reaching front edge of prosternum, segment lengths from base 0.58, 0.58, 0.38, 0.36; antennal segment I about twice as thick at middle as segment II, segment lengths from base 0.57, 1.10, 0.75, 1.06. *Pronotum*

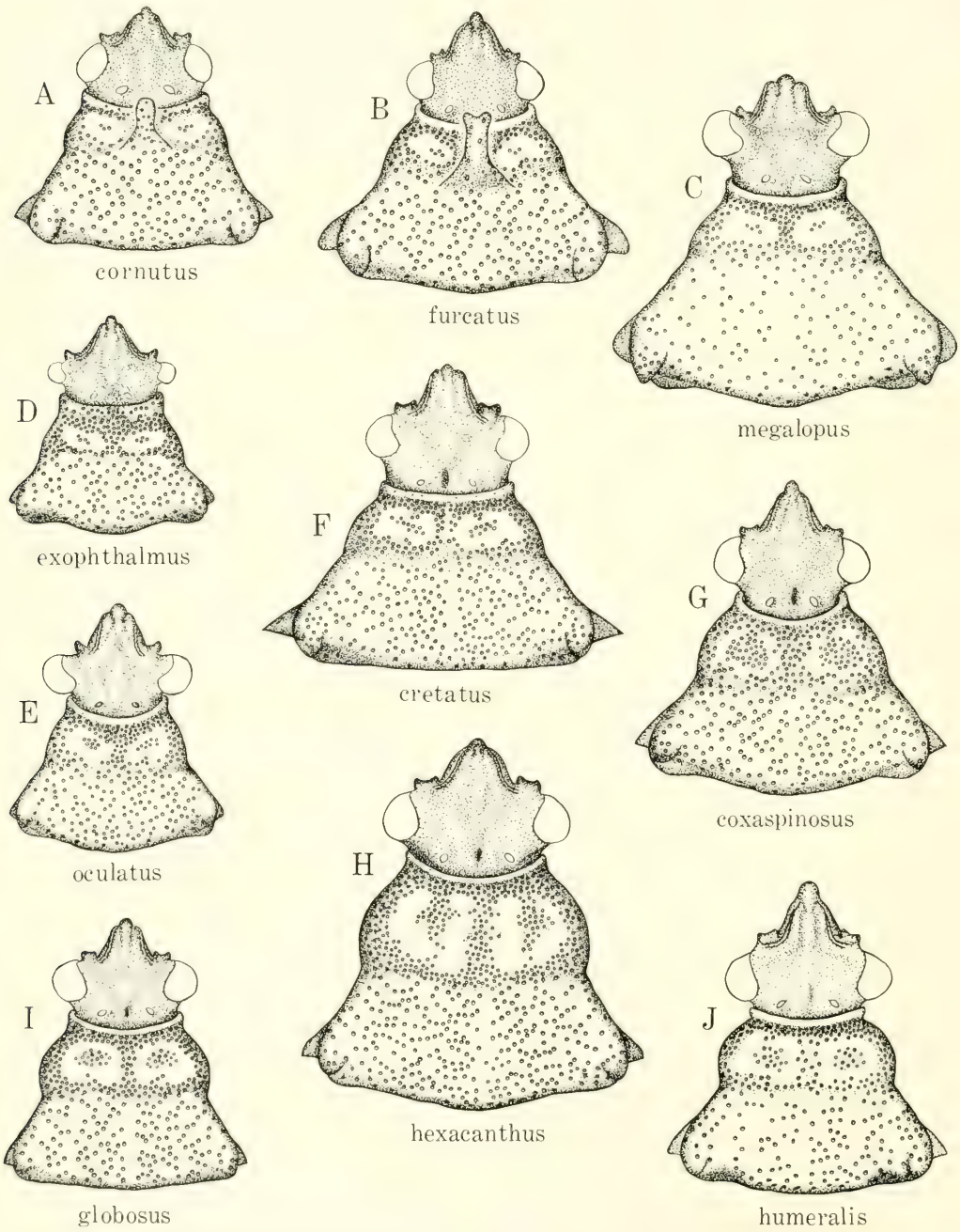

FIG. 4. Dorsal views of heads and thoraces of named species of *Bryanellocoris*.

with short, appressed seta in each puncture, setal length about equal to diameter of puncture; collar with fine shallow punctures; lateral margin of anterior lobe slightly convex, callosity with 8 to 10 fine punctures in center; humeral angle with dorsal tubercle inconspicuous and lateral carina blunt, rounded, and barely discernible; median length of pronotum 0.96, length of anterior lobe plus collar about two-fifths length of posterior lobe (0.27:0.69), width across collar 0.69, greatest width 1.75. *Scutellum* with slightly elevated central part of disc forming a Y-shaped carina; median length 0.99, width at base 0.96. *Hemelytron* exceeding abdomen by about three-fifths apical length of membrane; length of corium 2.88, length of claval commissure 0.62, basal length of membrane 1.41, apical length 1.06. *Thorax* ventrally with fine punctures, seta in each puncture longer than diameter of puncture; fore femur armed with 2 weak, bicolored, subapical spines with proximal tubercle of each spine conical and shorter than apical seta. *Color.* Head, collar and anterior lobe of pronotum, and venter of thorax except acetabulae and posterior metapleural plate dark reddish brown, acetabulae and posterior metapleural plate pale; posterior lobe of pronotum with posterior two-thirds pale yellowish brown and anterior one-third dark, blackish brown (or whole posterior lobe yellowish brown with irregular dark brown or blackish brown spots); abdomen ventrally dark yellowish brown with irregular streaks or spots on each side of posterior segments; scutellum with basal two-thirds reddish brown and apical one-third dark brown contrasting with pale yellow apex. Hemelytron pale yellowish brown, patterned with pale areas on clavus near apex within a pale brown area, and on corium at inner angle and along costal margin, and with dark spots apically and along costal margin one-quarter and two-thirds of distance from base. Membrane with faint dark pattern consisting of a medial V-shaped mark, a streak along posterior margin of corium, a median streak from apex of V to posterior margin, and streak on each side from near middle of arm of V running posteriorly and laterally almost to lateral margin. Femora pale yellowish brown, with subapical band incomplete and obscurely light brown, tibiae pale yellowish brown with both apex and subbase slightly darker. Antennal segment I brown, II and III yellowish brown with both ends slightly dark, segment IV reddish brown (or brown). Labium yellowish brown with apex dark. Length of holotype 4.97.

Holotype female, Indonesia (Irian Jaya): Wisselmeren, Obana, 1770 m, VIII-9-1955, JLG. *Paratypes,* 1 male, same data as holotype; Papua New Guinea: Morobe District, 1 male, Wau, Edie Creek, 2000 m, VIII-13-1963, "H.C.," collector unknown, 1 male, Mt. Kaindi, 2350 m, IX-6-1971, on *Vaccinium,* WCG.

Etymology: Spinulus, L. for little spine, referring to the weak femoral spine.

21. *Bryanellocoris gressitti* Chen & Ashlock, n. sp.

Head strongly deflexed, with anteocular length viewed from above much less than eye length (0.10:0.21); vertex flat between eyes; base of vertex without median sulcus; head length 0.79, width including eyes 0.93; anteocular length 0.33, width of interocular space 0.57; eye large, not stalked, with top much higher than vertex, eye length 0.27, width 0.18; labium short, reaching middle coxae, basal segment reaching front edge of prosternum, segment lengths from base 0.51, 0.34, 0.27, 0.38; antennal segment I about twice as thick at middle as segment II, segment lengths from base 0.67, 1.10, 0.75, 0.94. *Pronotum* with collar having small shallow punctures; anterior lobe with lateral margins moderately convex, callosity with 6 to 10 small punctures in center; humeral angle with dorsal tubercle inconspicuous and lateral carina narrow, blunt, and rounded; median length of pronotum 0.94, length of anterior lobe plus collar about one-half length of posterior lobe (0.34:0.60), width across collar 0.75, greatest width 1.61. *Scutellum* with elevated central part of disc forming a Y-shaped carina; median length 0.89, width at base 0.86. *Hemelytron* exceeding abdomen by about one-half (or two-thirds) apical length of membrane; length of corium 2.61, length of claval commissure 0.55, basal length of membrane 1.23, apical length 1.13. *Thorax* ventrally with small punctures, seta in each puncture much longer than diameter of puncture; fore femur armed with 2 weak, bicolored, subapical spines, distal subapical spine with proximal tubercle cylindrical and slightly longer than apical seta, second spine with tubercle conical (or cylindrical) and about equal in length to seta. *Color.* Head, anterior lobe and humeral angles of pronotum, venter of thorax except acetabulae and posterior metapleural plate, and scutellum except apex and stem of Y-shaped carina dark brown to dark reddish brown, acetabulae, posterior metapleural plate, scutellar apex, and stem of Y-shaped carina pale; abdomen ventrally dark yellowish brown, slightly and irregularly suffused with black; remaining parts with ground color yellowish brown. Hemelytron obscurely patterned on corium with pale areas at inner angle and along costal margin, and with dark spots apically and along costal margin

at one-quarter and two-thirds of distance from base, and at inner angle surrounding pale area. Membrane with faint dark pattern consisting of a medial V-shaped mark, a streak along posterior margin of corium, a single median streak from apex of V to posterior margin, and a streak on each side from near middle of arm of V running posteriorly and laterally almost to lateral margin. Femora pale yellowish brown, nearly unicolored (or at most with subapex very obscurely dark), tibiae pale yellowish brown with both apex and subbase slightly dark. Antennal segment I yellowish brown with apex pale, II and III yellowish brown with both ends slightly darker, segment IV reddish brown. Labium pale yellowish brown with apex dark. Length of holotype 4.80.

Holotype male, PAPUA NEW GUINEA: Eastern Highlands District, Mt. Otto, 2200 m, VI-23 to 24-1955, JLG. *Paratypes,* 4 males, 6 females, same data as holotype.

Etymology: Named for the late J. L. Gressitt.

22. *Bryanellocoris rostellus* Chen & Ashlock, n. sp.

Head strongly or moderately deflexed, with anteocular length viewed from above much less than eye length (0.10:0.21); vertex flat between eyes; base of vertex without median sulcus; head length 0.79, width including eyes 0.93; anteocular length 0.33, width of interocular space 0.55; eye large, not stalked, with top much higher than vertex, eye length 0.31, width 0.17; labium short, reaching middle coxae, basal segment reaching front edge of prosternum, segment lengths from base 0.57, 0.36, 0.24, 0.37; antennal segment I about twice as thick at middle as segment II, segment lengths from base 0.69, 1.27, 0.89, 1.23. *Pronotum* with collar having fine shallow punctures; anterior lobe with lateral margins moderately convex, callosity with 6 to 10 fine punctures in center; humeral angle with dorsal tubercle inconspicuous and lateral carina narrow, blunt, and rounded; median length of pronotum 1.01, length of anterior lobe plus collar about one-half length of posterior lobe (0.34:0.67), width across collar 0.72, greatest width 1.68. *Scutellum* with elevated central part of disc forming a Y-shaped carina; median length 0.89, width at base 0.86. *Hemelytron* exceeding abdomen by about two-fifths apical length of membrane; length of corium 2.64, length of claval commissure 0.51, basal length of membrane 1.27, apical length 1.20. *Thorax* ventrally with small punctures, seta in each puncture much longer than diameter of puncture; fore femur armed with 2 bicolored, subapical spines, distal subapical spine with proximal tubercle cylindrical and longer than apical seta, second spine with tubercle conical or nearly cylindrical and shorter than seta. *Color.* Head, collar, anterior lobe and humeral angles of pronotum, venter of thorax except acetabulae and posterior metapleural plate, and scutellum except apex and stem of Y-shaped carina dark reddish brown, acetabulae, posterior metapleural plate, scutellar apex, and stem of Y-shaped carina pale; abdomen ventrally reddish (or reddish brown suffused with black); remaining parts with ground color yellowish brown. Hemelytron patterned with pale areas on clavus near apex and on corium at inner angle, each within a large pale brown area, and pale along costal margin, with dark spots apically and along costal margin at one-quarter and two-thirds of distance from base. Membrane with faint dark pattern consisting of a medial V-shaped mark, a streak from apex of V to posterior margin, and a streak on each side from near middle of arm of V running posteriorly and laterally almost to lateral margin. Femora pale yellowish brown with subapical band distinct, broad and dark brown, tibiae pale yellowish brown with apex and subbase slightly darker. Antennal segment I brown, II and III yellowish brown with both ends slightly dark, segment IV reddish brown or brown. Labium yellowish brown with apex dark. Length of holotype 4.97.

Holotype male, PAPUA NEW GUINEA: Eastern Highlands District, Chimbu Valley, 1800 m, V-16-1963, JS. *Paratypes,* PAPUA NEW GUINEA: Morobe District, 1 female, Wau, 1200 m, VI-16-1961, JS, 1 male, Wau, Edie Creek Road, IX-8-1971, WCG; INDONESIA (IRIAN JAYA): 1 male, 1 female, Wisselmeren, Itouda, 1500 m, VIII-13-1955, Waghete, Tigi Lake, 1700 m, VIII-17-1955, JLG; 1 male, Swart Valley, Karubaka, 1450 m, XI-12-1958, JLG.

Etymology: Rostellus, L. for little rostrum, referring to the short labium or rostrum.

23. *Bryanellocoris piceus* Chen & Ashlock, n. sp.

Head strongly deflexed, with anteocular length viewed from above much less than eye length (0.10:0.21); vertex flat between eyes; glassy and shining dorsally, subshining ventrally; median sulcus at base of vertex absent (or obscure); head length 0.82, width including eyes 0.98; anteocular length 0.34, width of interocular space 0.55; eye large, not stalked, with top much higher than vertex, eye length 0.27, width 0.21; labium short, reaching middle coxae, basal segment longest, reaching front edge of prosternum, segment lengths from base 0.57, 0.37, 0.26, 0.39; antennal segment I about twice as thick at middle as segment II, segment lengths from base 0.65, 1.27, 0.89, 1.17. *Pronotum* glassy and shining; seta

in each puncture shorter than diameter of puncture, the few setae between punctures longer than diameter of puncture; collar with small and shallow punctures; lateral margin of anterior lobe slightly convex, callosity smooth and nearly impunctate with 3 to 5 punctures in center; humeral angle with dorsal tubercle moderate in size and lateral carina blunt and rounded; median length of pronotum 1.08, length of anterior lobe plus collar about one-half length of posterior lobe (0.36:0.72), width across collar 0.75, greatest width 1.89. *Scutellum* glassy and shining; slightly elevated central part of disc forming an inconspicuous Y-shaped carina; median length 1.03, width at base 0.97. *Hemelytron* glassy and shining; exceeding abdomen by about two-thirds apical length of membrane; length of corium 3.02, length of claval commissure 0.62, basal length of membrane 1.41, apical length 1.23. *Thorax* ventrally subshining, sparsely punctate, seta in each puncture longer than diameter of puncture; fore femur armed with 2 elongate, bicolored, subapical spines with proximal tubercle of each spine cylindrical and slightly longer

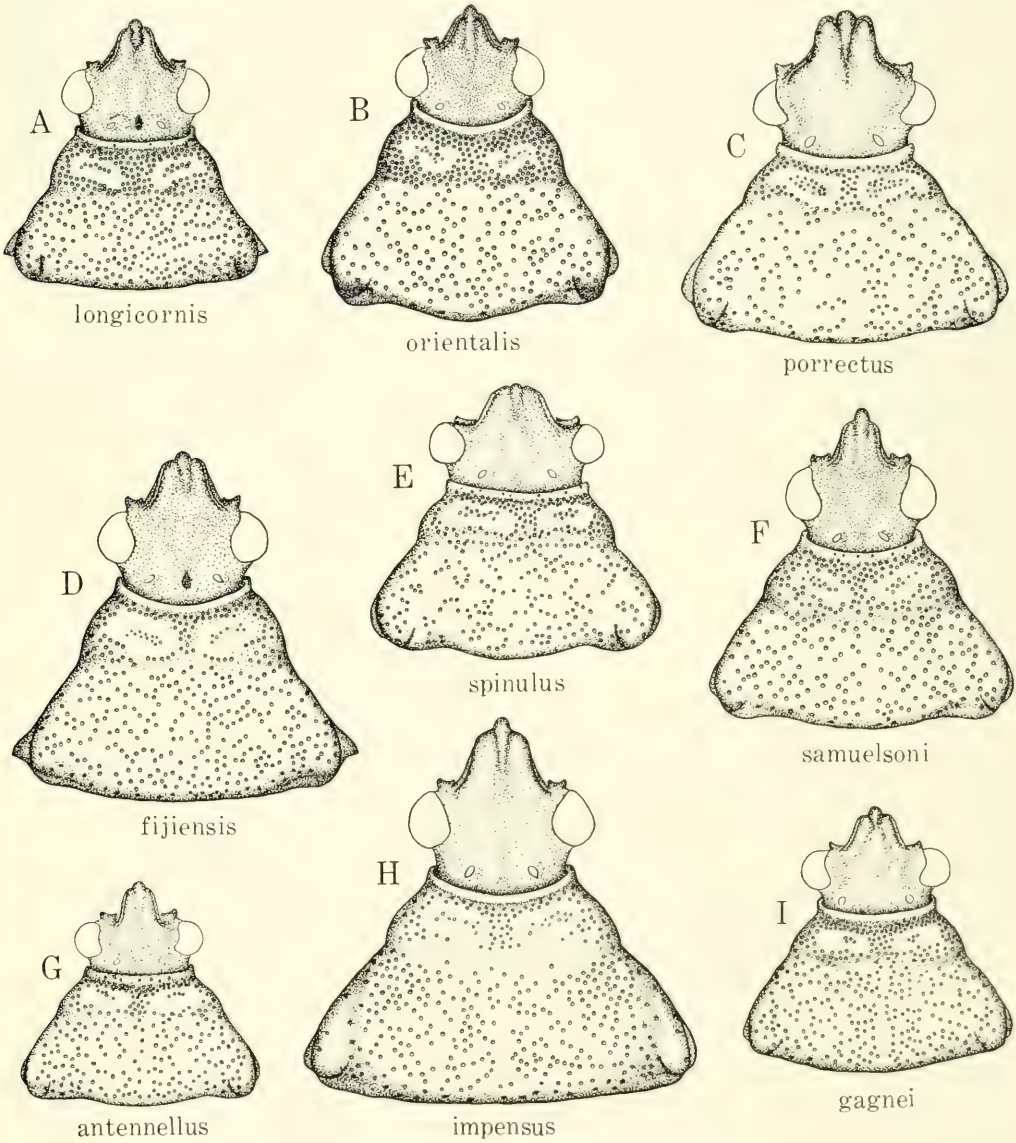

FIG. 5. Dorsal views of heads and thoraces of named species of *Bryanellocoris*.

than apical seta. *Color.* Head, collar and anterior lobe of pronotum, basal one-third of scutellum, and venter of thorax except acetabulae and posterior metapleural plate dark reddish brown (to nearly blackish brown), acetabulae and posterior metapleural plate pale; posterior lobe of pronotum blackish brown with irregular yellowish brown spots; scutellum reddish brown proximally, blackish brown apically; abdomen dark yellowish brown with dark stripes or spots on posterior abdominal segments. Hemelytron yellowish brown, patterned with obscure pale areas on clavus near apex, and on corium at inner angle, each within a large dark brown area, and along costal margin, and with dark spots apically and along costal margin at one-quarter and two-thirds of distance from base. Membrane with obscure dark pattern consisting of a medial V-shaped mark, a streak along posterior margin of corium, and a faint streak on side from near middle of arm of V running posteriorly and laterally almost to lateral margin. Femora pale yellow with subapical band conspicuous and dark brown, and with base slightly dark, tibiae yellowish brown with apex and subbase slightly darker. Antennal segment I brown or yellowish brown, II and III yellowish brown, segment IV reddish brown. Labium pale yellowish brown with both base and apex dark. Length of holotype 5.28.

Holotype female, PAPUA NEW GUINEA: Morobe District, Mt. Kaindi, 2360 m, XI-19 to 20-1971, WCG. *Paratype,* PAPUA NEW GUINEA: Morobe District, 1 male, Wau, 1950 m, IX-2-1977, WCG.

Etymology: Piceus, L. for pitchy black, referring to the relatively dark general appearance of the species.

24. *Bryanellocoris porrectus* Chen & Ashlock, n. sp.

Figs. 3A, 5C, 6F, 8B

Head very slightly deflexed, with anteocular length viewed from above much longer than eye length (0.36:0.24); vertex convex between eyes; median sulcus at base of vertex absent (or obscure); head length 0.82, width including eyes 0.97; anteocular length 0.39, width of interocular space 0.57; eye large, not stalked, with top lower than vertex, eye length 0.27, width 0.21; labium long, reaching hind coxae, basal segment reaching front edge of prosternum, segment lengths from base 0.86, 0.82, 0.55, 0.51; antenna long, segment I about 2.5 times as thick at middle as segment II, segment lengths from base 0.67, 1.58, 1.23, 1.37. *Pronotum* with collar impunctate dorsally; lateral margin of anterior lobe slightly convex, callosity with 15 to 20 fine shallow punctures in center; humeral angle with dorsal tubercle moderate in size and lateral carina small, blunt, and rounded; median length of pronotum 0.79, length of anterior lobe plus collar about one-half length of posterior lobe (0.39:0.79), width across collar 0.75, greatest width 1.96. *Scutellum* with elevated central part of disc forming a Y-shaped carina; median length 1.10, width at base 1.01. *Hemelytron* exceeding abdomen by about one-half apical length of membrane; length of corium 3.40, length of claval commissure 0.75, basal length of membrane 1.48, apical length 1.23. *Thorax* ventrally punctate, seta in each puncture longer than diameter of puncture; fore femur armed with 2 elongate, bicolored, subapical spines with proximal tubercle of each spine cylindrical and longer than apical seta, distal subapical spine shorter than proximal spine. *Color.* Head except tip of tylus, collar and anterior lobe of pronotum, basal quarter of scutellum and venter of thorax except acetabulae and posterior metapleural plate dark reddish brown, tip of tylus, acetabulae, and posterior metapleural plate pale; venter of abdomen brown suffused or dappled with irregular red; scutellum with apex pale yellow and with stem of Y-shaped carina pale; remaining parts with ground color yellowish brown. Hemelytron patterned on clavus with pale areas near apex and on corium at inner angle (and sometimes near apex), each within a large light brown area, and pale along costal margin, and with dark spots apically and along costal margin at two-thirds of distance from base. Membrane with dark pattern consisting of a medial V-shaped mark, an obscure broad streak posteriorly along costal margin of corium, an obscure short streak on each side from near middle of arm of V running posteriorly and laterally almost to lateral margin, and a median, narrow, fan-shaped spot from apex of V to posterior margin occupying about one-fifth of apical membrane. Femora yellowish brown with subapex slightly darker, without distinct band, tibiae yellowish brown and unicolored. Antennal segment I brown, II and III yellowish brown with apex suffused with red, segment IV reddish brown. Labium yellowish brown with apex dark. Length of holotype 6.04.

Holotype female, INDONESIA (IRIAN JAYA): Star Mts., Sibil Valley, 1245 m, X-18 to XI-8-1961, SQ&LQ. *Paratypes,* INDONESIA (IRIAN JAYA): 7 males, 4 females, Wisselmeren, Enarotadi, 1800 2050 m, VIII-5 to 19-1955, VIII-2 to 23-1962, JLG, 1 female, Swart Valley, Karubaka, XI-10-1958, light trap, JLG, 1 female, Swart Valley, Guega, 1200 m, XI-15-1958, JLG; PAPUA NEW GUINEA: Madang District, 1 female, Keglsugl, 2500-2700 m, VII-1-1963, JS; Western

Highlands District, 1 male, Nondugl, 1600 m, VII-9-1955, JLG.

Etymology: Porrectus, L. for extended, referring to the distinctive anteocular length of the head.

25. *Bryanellocoris notatus* Chen & Ashlock, n. sp.

Head moderately deflexed, with anteocular length viewed from above less than eye length (0.10:0.20); vertex nearly flat between eyes; base of vertex without median sulcus; head length 0.65, width including eyes 0.82; anteocular length 0.26, width of interocular space 0.45; eye large, not stalked, with top higher than vertex, eye length 0.24, width 0.19; labium long, reaching hind coxae, basal segment slightly exceeding front edge of prosternum, segment lengths from base 0.58, 0.58, 0.34, 0.34; antennal segment I about twice as thick at middle as segment II, segment lengths from base 0.57, 1.17, 0.98, 0.96. *Pronotum* with collar nearly impunctate dorsally; lateral margin of anterior lobe moderately convex, callosity with 6 to 10 fine and shallow punctures in center; posterior lobe with posterior margin apparently sinuate, humeral angle with dorsal tubercle moderate in size and lateral carina blunt and rounded; median length of pronotum 0.96, length of anterior lobe plus collar about two-thirds length of posterior lobe (0.38:0.58), width across collar 0.58, greatest width 1.49. *Scutellum* with elevated central part of disc forming a Y-shaped carina with stem inconspicuous; median length 0.75, width at base 0.86. *Hemelytron* comparatively dull; exceeding abdomen by about one-half apical length of membrane; length of corium 2.30, length of claval commissure 0.45, basal length of membrane 1.06, apical length 1.13. *Thorax* ventrally with sparse, fine or small punctures, seta in each puncture longer than diameter of puncture; fore femur armed with 2 elongate, bicolored, subapical spines with proximal tubercle of each spine cylindrical and slightly longer than apical seta. *Color.* Head, anterior lobe and humeral angles of pronotum, scutellum except apex, and venter of thorax except acetabulae and posterior metapleural plate dark reddish brown, scutellar apex pale yellow, acetabulae and posterior metapleural plate pale; collar brown; venter of abdomen brown, dappled with irregular black; remaining parts with ground color pale yellowish brown. Hemelytron patterned with obscure pale area on corium at inner angle within a large dark area, and with dark spots along costal margin at one-quarter and two-thirds of distance from base. Membrane relatively opaque, with dark pattern consisting of an obscure medial V-shaped mark, an obscure streak along posterior margin of corium, and a distinct, median, fan-shaped blackish brown spot from apex of V to posterior margin of membrane. Femora pale yellow, subapical band obscure and light brown on fore and middle femora, distinct and dark brown on hind femur, tibiae pale yellow with apex and subbase light brown. Antennal segment I brown, II and III pale yellowish brown with both ends slightly dark, segment IV dark reddish brown. Labium yellowish brown with apex dark. Length of holotype 4.49.

Holotype male, Papua New Guinea: Morobe District, Wau, Mt. Kaindi, 2360 m, XII-3-1977, WCG.

Etymology: Notatus, L. for marked, referring to the spotted corium and ventral abdomen.

26. *Bryanellocoris samuelsoni* Chen & Ashlock, n. sp.

Fig. 5F

Head strongly deflexed, with anteocular length viewed from above much shorter than eye length (0.10:0.22); vertex convex between eyes; base of vertex without median sulcus; head length 0.79, width including eyes 0.89; anteocular length 0.33, width of interocular space 0.51; eye large, not stalked, with top as high as vertex, eye length 0.27, width 0.19; labium long, reaching hind coxae, basal segment far exceeding front edge of prosternum, segment lengths from base 0.65, 0.65, 0.34, 0.34, antennal segment I about twice as thick at middle as segment II, segment lengths from base 0.62, 1.20, 0.86, 1.01. *Pronotum* with collar having small, shallow punctures; lateral margin of anterior lobe slightly convex, callosity with 6 to 10 fine, shallow punctures in center; humeral angle with dorsal tubercle inconspicuous and lateral carina very narrow, blunt, and rounded; median length of pronotum 0.99, length of anterior lobe plus collar less than two-thirds length of posterior lobe (0.36:0.63), width across collar 0.70, greatest width 1.72. *Scutellum* with elevated central part of disc forming a Y-shaped carina with stem inconspicuous; median length 0.96, width at base 0.91. *Hemelytron* exceeding abdomen by about one-third apical length of membrane; length of corium 2.68, length of claval commissure 0.62, basal length of membrane 1.23, apical part of membrane broken. *Thorax* ventrally with sparse, coarse punctures; fore femur armed with 2 elongate, bicolored, subapical spines with proximal tubercle of each spine cylindrical and longer than apical seta. *Color.* Head, collar and anterior lobe of pronotum, base of scutellum, and venter of thorax except acetabulae and posterior metapleural plate dark reddish brown, acetabulae and

posterior metapleural plate pale; apical portion of scutellum brown with apex pale yellow and stem of Y-shaped carina black; venter of abdomen brown suffused irregularly with black; remaining parts with ground color pale yellowish brown. Hemelytron contrastingly patterned on clavus with pale areas near apex, and on corium at inner angle, each within a large brown area, and pale along costal margin, and with dark spots apically and along costal margin at one-quarter and two-thirds of distance from base. Membrane with dark pattern consisting of an obscure, medial, V-shaped mark, an obscure broad streak along posterior margin of corium, and a median, fan-shaped, dark brown spot from apex of V to posterior margin, fan-shaped spot distinct, broad, and occupying about one-third of apical portion of membrane. Femora pale yellow with subapical band obscurely light brown, tibiae pale yellow with apex and subbase slightly darker. Antennal segment I brown, II and III yellowish brown, segment IV dark reddish brown. Labium pale yellow. Length of holotype 3.64 (not including broken apical membrane).

Holotype female, PAPUA NEW GUINEA: Morobe District, Unboi Is., summit, 1125 m peak, 3 km N Awelkom, II-24-1967, GAS.

Etymology: Named for G. A. Samuelson of the Bishop Museum, Honolulu, Hawaii.

27. *Bryanellocoris russatus* Chen & Ashlock, n. sp.

Head very slightly deflexed, with anteocular length viewed from above much longer than eye length (0.29:0.21); vertex convex between eyes; base of vertex without median sulcus; head length 0.79, width including eyes 0.86; anteocular length 0.34, width of interocular space 0.52; eye moderate in size, not stalked, with top lower than vertex, eye length 0.24, width 0.17; labium long, reaching hind coxae, basal segment reaching front edge of prosternum, segment lengths from base 0.69, 0.65, 0.41, 0.49; antennal segment I about 3 times as thick at middle as segment II, segment lengths from base 0.50, 1.03, 0.82, 0.89. *Pronotum* with collar nearly impunctate dorsally; lateral margin of anterior lobe slightly convex, callosity with 7 to 9 small punctures in center; humeral angle with dorsal tubercle moderate in size and lateral carina small, blunt, and rounded; median length of pronotum 1.01, length of anterior lobe plus collar about one-half length of posterior lobe (0.34:0.67), width across collar 0.67, greatest width 1.63. *Scutellum* with elevated central part of disc forming a Y-shaped carina; median length 0.86, width at base 0.84. *Hemelytron* exceeding abdomen by about one-third (to two-fifths) apical length of membrane; length of corium 2.61, length of claval commissure 0.55, basal length of membrane 1.13, apical length 1.03. *Thorax* ventrally with coarse punctures; seta in each puncture longer than diameter of puncture; fore femur armed with 2 moderate-sized, unicolored subapical spines, distal subapical spine with proximal tubercle cylindrical and longer than apical seta, second spine with tubercle conical and shorter than seta. *Color.* Dorsal surface of head, anterior lobe of pronotum, base of scutellum, and venter of thorax except acetabulae and posterior metapleural plate dark reddish brown, acetabulae and posterior metapleural plate pale; venter of abdomen yellowish brown suffused or dappled irregularly with red; remaining parts with ground color yellowish brown. Hemelytron patterned with pale areas on clavus near apex and on corium at inner angle, each within a large brown area, and pale along costal margin with dark spot apically and along costal margin at one-quarter and two-thirds of distance from base (pattern sometimes obscure). Membrane with dark pattern consisting of a medial V-shaped mark, a broad streak along posterior margin of corium, and a large, median, fan-shaped, dark brown spot from apex of V to posterior margin occupying about one-third of apical portion of membrane. Femora yellowish brown, with subapical band broad, dark brown, suffused with red, tibiae yellowish brown with both apex and subbase suffused with red. Antennal segment I reddish brown, II and III yellowish brown with both ends red, segment IV dark reddish brown. Labium brown with apex dark. Length of holotype 5.04.

Holotype female, PAPUA NEW GUINEA: Southern Highlands District, Mt. Bosavi, 2300 m, V-9-1973, JLG. *Paratypes,* 1 male, same data as holotype; INDONESIA (IRIAN JAYA): 1 female, Wisselmeren, Enarotadi, 1900 m, VIII-1-1955, JLG.

Etymology: Russatus, L. for clothed in red.

28. *Bryanellocoris longirostrus* Chen & Ashlock, n. sp.

Head slightly deflexed, with anteocular length viewed from above longer than eye length (0.24:0.21); vertex convex between eyes; base of vertex without median sulcus; head length 0.72, width including eyes 0.77; anteocular length 0.34, width of interocular space 0.46; eye moderate in size, not stalked, with top lower than vertex, eye length 0.21, width 0.15; labium long, slightly exceeding posterior edge of second abdominal segment, basal segment far exceeding anterior edge of prosternum, segment lengths

from base 0.74, 0.77, 0.77, 0.41; antenna long, segment I about 2.5 times as thick at middle as segment II, segment lengths from base 0.50, 1.34, 1.10, 0.99. *Pronotum* with collar having small shallow punctures; lateral margin of anterior lobe slightly convex, callosity with about 8 to 10 small punctures in center; humeral angle with dorsal tubercle inconspicuous and lateral carina narrow, blunt, and rounded; median length of pronotum 0.89, length of anterior lobe plus collar about one-half length of posterior lobe (0.31:0.58), width across collar 0.60, greatest width 1.48. *Scutellum* with elevated central part of disc forming a Y-shaped carina; median length 0.74, width at base 0.72. *Hemelytron* exceeding abdomen by about three-fifths apical length of membrane; length of corium 2.50, length of claval commissure 0.58, basal length of membrane 1.20, apical length 0.99. *Thorax* ventrally with sparse, coarse punctures, seta in each puncture much longer than diameter of puncture; fore femur armed with 2 (with tiny third on one side of holotype) weak, bicolored, subapical spines, distal subapical spine with proximal tubercle nearly cylindrical and slightly shorter than apical seta, second spine with tubercle conical and much shorter than seta. *Color.* Whole body rather pale and evenly colored. Head, anterior lobe of pronotum, scutellum except Y-shaped carina, and venter of thorax except acetabulae and posterior metapleural plate dark reddish brown, Y-shaped carina, acetabulae, and posterior metapleural plate pale; remaining parts with ground color pale yellowish brown. Hemelytron obscurely pat-

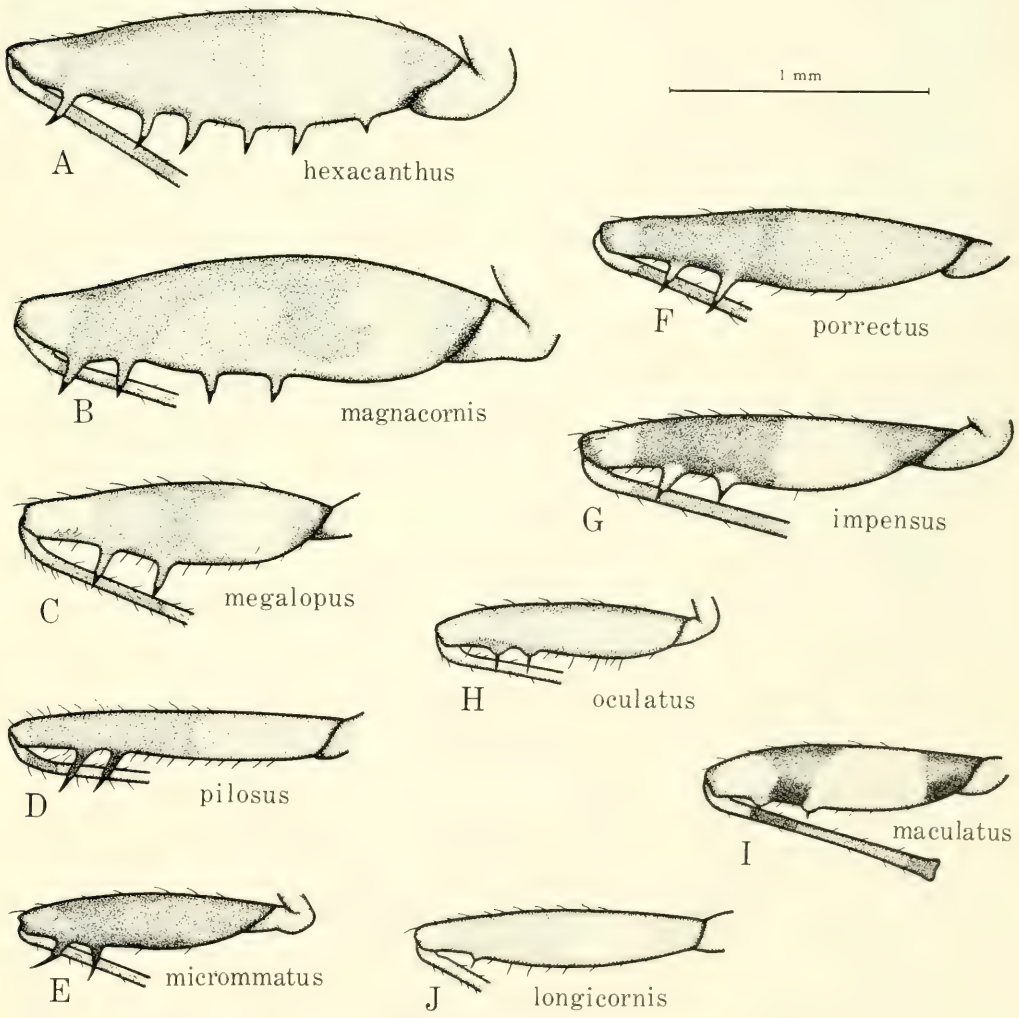

FIG. 6. Fore femora of named species of *Bryanellocoris*.

terned with pale area on corium at inner angle with dark spots apically and along costal margin at two-thirds of distance from base. Membrane with dark pattern consisting of an obscure medial V-shaped mark, an obscure broad streak along posterior margin of corium, and a median, fan-shaped, light brown spot from apex of V to posterior margin occupying about one-quarter of apical portion of membrane. Femora and tibiae pale yellowish brown, antenna with segment I light brown suffused with red, II and III pale yellowish brown, at most with only tip slightly suffused with red. Labium pale yellowish brown with apex slightly dark. Length of holotype 4.70.

Holotype male, INDONESIA (IRIAN JAYA): NE Swart Valley, Karubaka, 1450 m, XI-21-1958, JLG.

Etymology: Longirostrus, L. for long rostrum, referring to the distinctive length of the labium or rostrum.

29. *Bryanellocoris adustus* Chen & Ashlock, n. sp.

Head moderately deflexed, with anteocular length viewed from above about equal to eye length (0.21:0.21); vertex very slightly convex between eyes; base of vertex without median sulcus; subshining both dorsally and ventrally; head length 0.65, width including eyes 0.81, anteocular length 0.31, width of interocular space 0.48; eye moderate in size, not stalked, with top very slightly lower than vertex, eye length 0.21, width 0.16; labium long, reaching hind coxae, basal segment reaching front edge of prosternum, segment lengths from base 0.58, 0.51, 0.34, 0.38; antennal segment I about 2.5 times as thick at middle as segment II, segment lengths from base 0.53, 0.96, 0.65, 0.86. *Pronotum* subshining; collar almost impunctate dorsally; lateral margin of anterior lobe moderately convex, callosity with 5 or 6 shallow punctures in center; humeral angle with dorsal tubercle inconspicuous and lateral carina blunt, rounded, and barely discernible; median length of pronotum 0.91, length of anterior lobe plus collar about one-half length of posterior lobe (0.31:0.60), width across collar 0.27, greatest width 1.51. *Scutellum* subshining; slightly elevated central part of disc forming a Y-shaped carina with stem inconspicuous; median length 0.81, width at base 0.79. *Hemelytron* subshining to shining, exceeding abdomen by about two-fifths apical length of membrane; length of corium 2.26, length of claval commissure 0.48, basal length of membrane 0.99, apical length 0.96. *Thorax* ventrally subshining, sparsely and coarsely punctate; fore femur armed with 2 (or 1—right and left legs differ on holotype) bicolored, subapical spines, distal subapical spine with proximal tubercle nearly cylindrical and longer than apical seta, second spine much smaller than first, tubercle conical and shorter than seta. *Color.* Whole body dark. Head, collar and anterior lobe of pronotum, and venter of thorax very dark reddish brown; scutellum except apical one-quarter, and venter of abdomen reddish brown, apical one-quarter of scutellum black; remaining parts with ground color dark yellowish brown. Hemelytron patterned with pale areas on corium at inner angle and along costal margin, and with dark brown or black spots apically and along costal margin at one-quarter and two-thirds of distance from base. Membrane with dark pattern consisting of a medial V-shaped mark, an obscure streak along posterior margin of corium, and a distinct, median, fan-shaped, blackish brown spot from apex of V to posterior margin occupying slightly more than one-third of apical portion of membrane. Femora pale yellowish brown, subapical band imprecise and light brown on fore and middle femora, definite and dark brown on hind femur, tibiae pale yellowish brown with both apex and subbase dark. Antennal segment I brown, II and III dark yellowish brown, segment IV reddish brown. Labium dark yellowish brown with apex dark. Length of holotype 4.26.

Holotype male, PAPUA NEW GUINEA: Southern Highlands District, Mt. Giluwe, 2700 m, XII-29-1977, WCG.

Etymology: Adustus, L. for brown, referring to the general color of the insect.

30. *Bryanellocoris antennellus* Chen & Ashlock, n. sp.

Figs. 5G, 9A

Head moderately deflexed, with anteocular length viewed from above about equal to or slightly longer than eye length (0.17:0.17); vertex convex between eyes; base of vertex without median sulcus; head length 0.60, width including eyes 0.70; anteocular length 0.27, width of interocular space 0.41; eye moderate in size, not stalked, with top lower than vertex, eye length 0.21, width 0.14; labium long, reaching hind coxae (or as far as second visible abdominal segment), basal segment reaching front edge of prosternum, segment lengths from base 0.53, 0.48, 0.43, 0.33; antenna short, antennal segment I about twice as thick at middle as segment II, segment lengths from base 0.45, 0.86, 0.58, 0.72. *Pronotum* with collar having small and shallow punctures; lateral margin of anterior lobe slightly convex, callosity with about 3 to 5 fine punctures in center; humeral angle with dorsal

tubercle inconspicuous and lateral carina blunt, rounded, and barely discernible; median length of pronotum 0.79, length of anterior lobe plus collar slightly less than one-half length of posterior lobe (0.24:0.55), width across collar 0.55, greatest width 1.34. *Scutellum* with slightly elevated central part of disc forming a Y-shaped carina with stem obscure; median length 0.65, width at base 0.69. *Hemelytron* exceeding abdomen by about two-fifths apical length of membrane; length of corium 2.13, length of claval commissure 0.48, basal length of membrane 0.96, apical length 0.86. *Thorax* ventrally with sparse, fine punctures; fore femur armed with 2 weak, bicolored to nearly unicolored, subapical spines, distal subapical spine with proximal tubercle conical or cylindrical and shorter than apical seta, second spine much smaller than first, and with tubercle conical and much shorter than seta. *Color.* Head, collar and anterior lobe of pronotum, basal scutellum, and venter of thorax except acetabulae and posterior metapleural plate dark reddish brown, acetabulae and posterior metapleural plate pale; venter of abdomen yellowish brown with broad longitudinal dark brown or black streak along each lateral margin; remaining parts with ground color yellowish brown. Hemelytron pale, unpatterned (or patterned with scattered light brown areas). Membrane with dark pattern consisting of a medial V-shaped mark, a streak along posterior margin of corium, a median oval or T-shaped spot (usually obscure) in front of V, and a fan-shaped spot from apex of V to posterior margin occupying about one-quarter of apical portion of membrane (pattern on membrane sometimes obscure and barely discernible). Femora and tibiae pale yellowish brown, unicolored. Antennal segments I-III yellowish brown, suffused with red (no red in some specimens), segment IV dark reddish brown. Labium yellowish brown with apex dark. Length of holotype 3.98.

Holotype male, Papua New Guinea: Morobe District, near Wau, E Mt. Kaindi, 2000 m, II-17-1977, on Melastomataceae *(Poikilogyne),* WCG. *Paratypes,* 2 males, same data as holotype; 10 males, 7 females, same data as holotype except 1350 m, II-11-1955, 1300 m, V-19-1955; Papua New Guinea: Madang District, 1 male, Mt. Wilhelm, 3000 m, IV-4-1955, JLG; Morobe District, 8 males, 1 female, Wau, 2360 m, II-19 to IV-29-1955, 2350 m, III-26-1977, light trap, WCG, 2350 m, III-23 to IV-1-1966, JL&MG, 1 female, Wau, 2400 m, I-9 to 12-1962, JMS, 1 male, 1 female, Edie Creek, 17.6 km W Wau, 2000 m, VII-20-1961, JMS; Southern Highlands District, 8 males, 9 females, Dimifa, SE Mt. Giluwe, 2200-2350 m, X-10 to 11-1958, JLG; Western Highlands District, 1 male, 1 female, Wum, upper Jimi Valley, 840 m, VIII-17 to 18

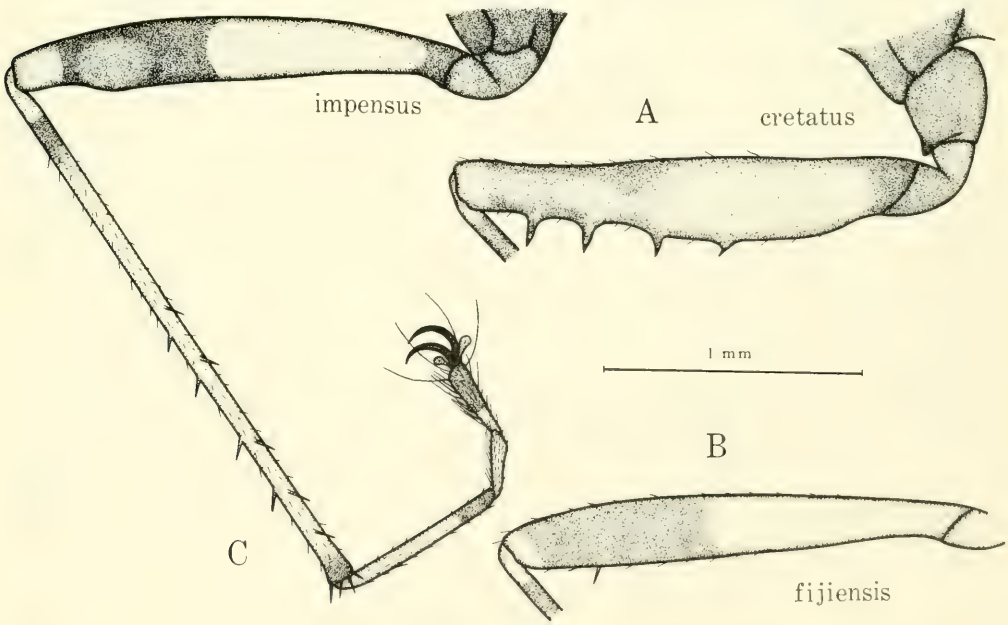

FIG. 7. A. Basal part of fore leg of *Bryanellocoris cretatus.* B. Hind femur of *B. fijiensis.* C. Hind leg of *B. impensus.*

1955, JLG, 1 female, 6.4 km W Wabag, 2020 m, VI-13-1963, JS; 1 female, Kepilam, 2400 m, VI-20 to 22-1963, light trap, JS. INDONESIA (IRIAN JAYA): 7 males, 6 females, Wisselmeren, Enarotadi, 1800 m, Obano, 1770 m, Urapura Kamo Valley, 1530 m, light trap, Itoud Kamo Valley, 1500 m, Durota, E Enarotadi, 1800 m, VIII-3 to 21-1955, JLG.

Etymology: Antennellus, L. for small antenna, referring to the relative shortness of the antenna.

31. *Bryanellocoris philippinensis* Slater

Bryanellocoris philippinensis Slater, 1965: 71-75.

Head slightly deflexed, with anteocular length viewed from above much longer than eye length (0.26:0.17); vertex slightly convex between eyes; median sulcus at base of vertex obscure; dorsal surface with sparsely scattered, long, erect hairs; head length 0.72, width including eye 0.79; anteocular length 0.36, width of interocular space 0.48; eye moderate in size, not stalked, with top as high as vertex, eye length 0.22, width 0.15; labium long, reaching hind coxae, basal segment short, falling far short of prosternum, segment lengths from base 0.46, 0.48, 0.82, 0.31; antennal segment I twice as thick at middle as segment II, segment lengths from base 0.62, 1.20, 1.03, 1.03. *Pronotum* with sparse, scattered, long, erect hairs arising between punctures and short appressed hairs in each puncture; collar impunctate dorsally; lateral margin of anterior lobe moderately convex, callosity with about 10 to 12 very fine and shallow punctures in center; humeral angle with dorsal tubercle inconspicuous and lateral carina very narrow, blunt, rounded, and barely discernible; median length of pronotum 0.96, length of anterior lobe plus collar about two-thirds length of posterior lobe (0.38:0.58), width across collar 0.62, greatest width 1.34. *Scutellum* with sparse, scattered, long, erect hairs arising between punctures; central part of disc without a Y-shaped carina: median length 0.69, width at base 0.65. *Hemelytron* exceeding abdomen by about one-third apical length of membrane; length of corium 2.37, length of claval commissure 0.55, basal length of membrane 0.99, apical length 0.99. *Thorax* ventrally with sparse, very fine punctures; fore femur armed with 2 elongate, unicolored, subapical spines with proximal tubercle of each spine cylindrical and about equal to apical seta. *Color.* Head, collar and anterior lobe of pronotum, and venter of thorax except median stripe of apical one-half dark reddish brown, apical thoracic median stripe pale; posterior lobe of pronotum dark brown; venter of abdomen brown with posterior segments dark brown. Hemelytron yellowish brown, patterned with pale areas on corium at inner angle in a large dark area, and along costal margin, and with dark spots apically and along costal margin at one-quarter and two-thirds of distance from base. Membrane less transparent, with an irregular broad stripe just anterior to apex of abdomen running laterally and somewhat posteriorly from midline to lateral margins. Femora pale yellowish brown with subapical band brown, tibiae yellowish brown, with both apex and subbase dark. Antennal segments I-III yellowish brown, segment I with apex pale and subapex dark, segment IV brown, Labium yellowish brown with apex dark. Length of paratype 4.49.

The description is based on a male paratype from the PHILIPPINES: Mindanao, Mt. Apo, Mainit River, 1980 m, X-20, C. S. Clagg (C. F. Clagg on label), J. A. Slater collection.

The holotype is from the Philippines (Mindanao, Davao Province, Lawa, 5 May [year?], C. S. Clagg), and was deposited in the Museum of Comparative Zoology, Harvard University, Cambridge, Mass. However, the entire M.C.Z. collection of Heteroptera, including types, was given to the American Museum of Natural History, New York.

The Bishop Museum collection contains a single female from the Philippines (Mountain Province, Abatan, Buguias, 60 km S of Bontoc, 1800-2000 m, IV-1 to 4-1964, collected at a light trap by H. M. Torrevillas) that is clearly distinct from Slater's species. Its color is paler, and unlike *B. philippinensis,* it has short, rounded humeral carinae. Unfortunately, antennal parts, the labium, and both fore femora are missing from the specimen, and it cannot be further considered here.

32. *Bryanellocoris sedlaceki* Chen & Ashlock, n. sp.

Fig. 9B

Head slightly deflexed, with anteocular length viewed from above about equal to or slightly more than eye length (0.27:0.24); vertex convex between eyes; base of vertex without median sulcus; head length 0.79, width including eyes 0.96, anteocular length 0.36, width of interocular space 0.55; eye large, not stalked, with top lower than vertex, eye length 0.27, width 0.21; labium long, reaching (or slightly exceeding) hind coxae, basal segment exceeding front edge of prosternum, segment lengths from base 0.79, 0.74, 0.65, 0.38; antennal segment I about twice as thick at middle as segment II, segment lengths from base 0.51, 1.10, 0.86, 0.96. *Pronotum* with collar hav-

ing small shallow punctures; lateral margin of anterior lobe moderately convex, callosity with about 10 to 12 punctures in center; humeral angle with dorsal tubercle inconspicuous and lateral carina blunt and rounded; median length of pronotum 0.96, length of anterior lobe plus collar about two-thirds length of posterior lobe (0.38:0.58), width across collar 0.72, greatest width, 1.65. *Scutellum* with elevated central part of disc forming an inconspicuous Y-shaped carina; median length 0.94, width at base 0.94. *Hemelytron* exceeding abdomen by about three-sevenths apical length of membrane; length of corium 2.78, length of claval commissure 0.62, basal length of membrane 1.27, apical length about 1.20 (apex broken). *Thorax* ventrally with sparse, fine punctures, seta in each puncture slightly longer than diameter of puncture; fore femur armed with 2 strong, elongate, bicolored (or unicolored), subapical spines with proximal tubercle of each spine cylindrical and longer than apical seta. *Color.* Whole body rather dark. Head, collar and anterior lobe of pronotum, base of scutellum, and venter of thorax reddish brown to very dark reddish brown; head and anterior lobe of pronotum dark brown (sometimes anterior lobe only slightly darker than hind lobe); posterior lobe of pronotum yellowish brown, areas among punctures suffused irregularly with dark brown; apical one-half of scutellum reddish

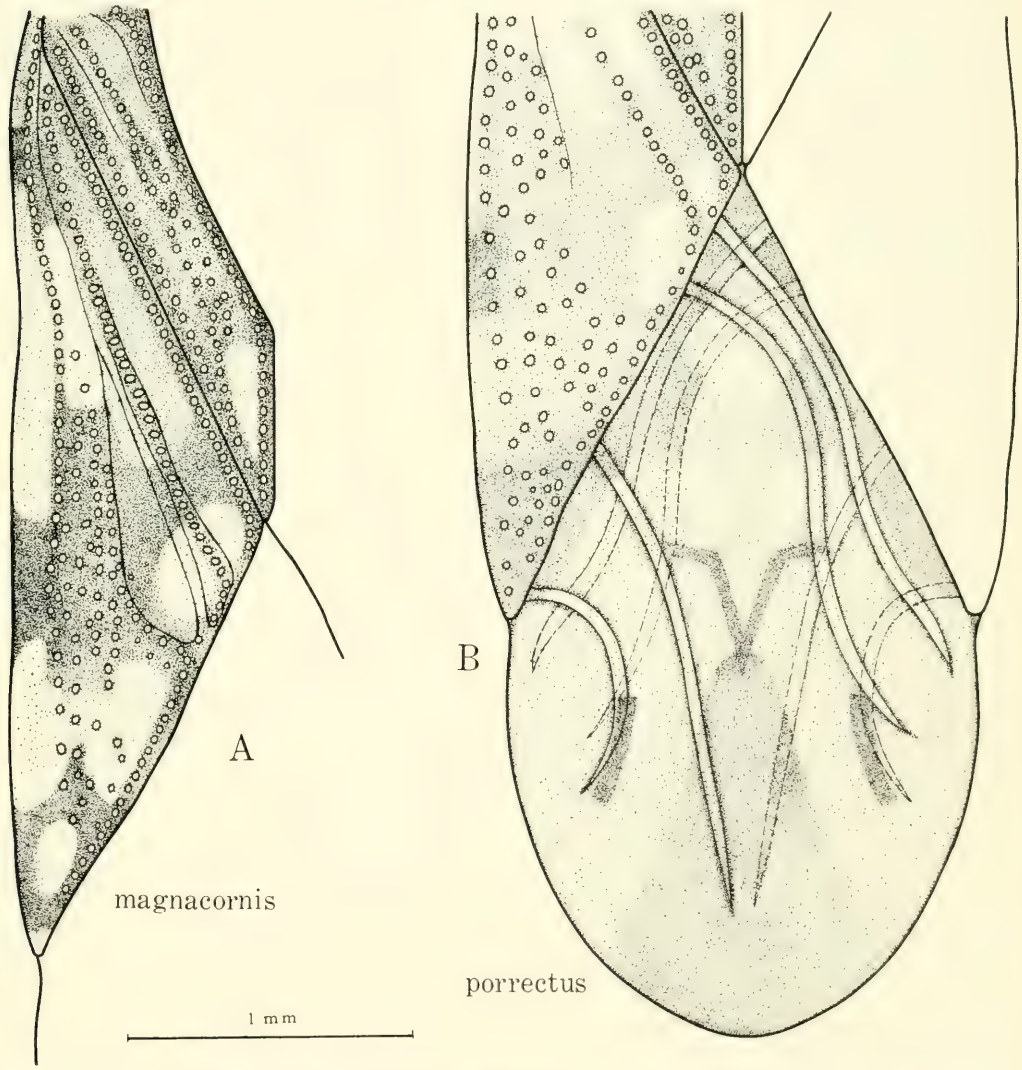

FIG. 8. A. Clavus and corium of *Bryanellocoris magnacornis*. B. Corium and membrane of *B. porrectus*.

brown with apex pale yellow and stem of Y-shaped carina black (stem sometimes pale); venter of abdomen reddish (or yellowish) brown, suffused irregularly with black. Hemelytron ground color light yellowish brown, patterned with pale areas near apex of clavus and on corium at inner angle within a large brown area, and pale along costal margin interrupted with dark spots apically and along costal margin at one-quarter and two-thirds of distance from base. Membrane with obscure dark pattern consisting of a medial V-shaped mark, a streak along posterior margin of corium, a median streak from apex of V to posterior margin and a streak on each side running from middle of arm of V to lateral margin. Femora yellowish brown with subapical band distinct and dark brown, tibiae yellowish brown with subbase dark brown and with apex slightly dark. Antenna brown, segments I-III apically suffused with red, segment IV slightly paler than segments I-III. Labium dark yellowish brown with apex blackish brown. Length of holotype 5.32.

Holotype male, INDONESIA (IRIAN JAYA): Wissellmeren, Enarotadi, 1850 m, VII-18 to 19-1962, Malaise trap, JS. *Paratypes,* 1 male, 1 female, same data as holotype; PAPUA NEW GUINEA: West Sepik District, 1 male, Eliptamin Valley, 1200-1350 m, VII-16 to 31-1959, WWB; Western Highlands District, 1 male, Korop, upper Jimi Valley, 1300 m, VII-12-1955, light trap, JLG.

Etymology: Named for J. H. Sedlacek, formerly of the Bishop Museum.

33. *Bryanellocoris impensus* Chen & Ashlock, n. sp.

Figs. 5H, 6G, 7C, 9C

Head slightly deflexed, with anteocular length viewed from above much longer than eye length (0.33:0.24); vertex convex between eyes; base of vertex without median sulcus; head length 0.86, width including eyes 1.04; anteocular length 0.41, width of interocular space 0.58; eye large, not stalked, with top lower than vertex, eye length 0.28, width 0.23; labium long, reaching posterior edge of hind coxae (or as far as posterior edge of second visible abdominal segment), basal segment exceeding front edge of prosternum, segment lengths from base 0.93, 0.87, 0.58, 0.58; antennal segment I about 2.5 times as thick at middle as segment II, segment lengths from base 0.75, 1.51, 1.13, 1.08. *Pronotum* with seta in each puncture equal to or longer than diameter of puncture; collar nearly impunctate dorsally; lateral margin of anterior lobe moderately convex, callosity with about 8 to 10 small, shallow punctures in center; posterior lobe with posterior margin slightly sinuate, humeral angle with dorsal tubercle moderate in size and lateral carina narrow, blunt, and rounded; median length of pronotum 1.27, length of anterior lobe plus collar about one-half length of posterior lobe (0.41:0.86), width across collar 0.81, greatest width 2.30. *Scutellum* with elevated central part of disc forming a thick Y-shaped carina; median length 1.27, width at base 1.30. *Hemelytron* with seta in each puncture longer than diameter of puncture; membrane exceeding abdomen by about one-half apical length; length of corium 3.81, length of claval commissure 0.79, basal length of membrane 1.72, apical length 1.41. *Thorax* finely and sparsely punctate ventrally, seta in each puncture much longer than diameter of puncture; fore femur armed with 2 strong, bicolored, subapical spines with tubercle longer than apical seta, distal subapical spine with tubercle cylindrical, second spine with tubercle conical. *Color.* Whole body rather dark. Head, collar and anterior lobe of pronotum, base of scutellum, and venter of thorax except acetabulae and posterior metapleural plate dark reddish brown (or nearly blackish brown), acetabulae and posterior metapleural plate pale; posterior lobe of pronotum yellowish brown, each side with a large irregular black spot (or a longitudinal black stripe, or several small irregular black spots); scutellum with central Y-shaped carina reddish brown, paler than remaining part, stem bordered with a V-shaped black spot (often absent), apex pale yellow; venter of abdomen reddish brown with small irregular black spots. Hemelytron with ground color yellowish brown, patterned with pale areas on clavus near apex and on corium at inner angle, each within a large brown area, and along costal margin, and with dark spots apically and along costal margin at one-quarter and two-thirds of distance from base. Membrane with obscure dark pattern consisting of a medial V-shaped mark, a streak along posterior margin of corium, a single median streak running from apex of V to posterior margin and a streak on each side from near middle of arm of V running laterally and posteriorly almost to lateral margin. Femora pale yellow with contrasting subapical band definite and dark brown, and with base dark but less contrasting, tibiae pale yellow with apex and subbase dark brown. Antennal segment I dark brown, II and III yellowish brown, III with basal end dark brown and apex reddish, segment IV reddish brown. Labium yellowish brown with apex dark. Length of holotype 6.72.

Holotype female, PAPUA NEW GUINEA: Morobe District, Mt. Kaindi, 2360 m, XII-11-1976, light

trap, WCG. *Paratypes,* 2 females, same data as holotype; Papua New Guinea: Morobe District, 6 males, 4 females, Mt. Kaindi, 16 km SW Wau, 2300 m, VI-8 to 9-1962, JS, 5 males, 10 females, Bulldog Road, 32 km S Wau, 2850 m, V-29 to 30-1962, JS, 40 km S Wau, 2400-2800 m, V-22 to 31-1967, JS, 14 km S Edie Creek, 2405 m, VII-4 to 10-1966, GAS, S Wau, 2400-2700 m, V-28-1976, on *Dimorphanthere,* 2700-2950 m, VI-25-1976, 2700-2950 m, 1977, 2100-2400 m, VI-17 to 20-1978, on Ericaceae *(Gaultheria pullei),* WCG; Indonesia (Irian Jaya): 1 male, Star Mts., Sibil Valley, 1245 m, X-18 to XI-8-1961, SQ&LQ.

Etymology: Impensus, L. for large, referring to the stature of the insect.

34. *Bryanellocoris tensus* Chen & Ashlock, n. sp.

Head very slightly deflexed, with anteocular length viewed from above more than eye length (0.31:0.22); vertex convex between eyes; base of vertex without median sulcus; head length 0.75, width including eyes 0.89; anteocular length 0.36, width of interocular space 0.51; eye moderate in size, not stalked, with top lower than vertex, eye length 0.24, width 0.19; labium long, reaching posterior edge of hind coxae, basal segment slightly exceeding front edge of prosternum, segment lengths from base 0.81, 0.72, 0.46, 0.48; antennal segment I about twice as thick at middle as segment II, segment lengths from base 0.68, 0.82, 1.20, 1.17. *Pronotum* with collar having fine punctures; lateral margin of anterior lobe moderately convex, callosity with about 8 to 10 fine, shallow punctures in center; humeral angle with dorsal tubercle inconspicuous and lateral carina blunt, rounded, and barely discernible; median length of pronotum 0.99, length of anterior lobe plus collar about one-half length of posterior lobe (0.33:0.67), width across collar 0.67, greatest width 1.75. *Scutellum* with elevated central part of disc forming a Y-shaped carina; median length 0.94, width at base 0.94. *Hemelytron* exceeding abdomen by about one-half apical length of membrane; length of corium 2.81, length of claval commissure 0.58, basal length of membrane 1.27, apical length 1.20. *Thorax* ventrally with small punctures, seta in each puncture longer than diameter of puncture; fore femur armed with 2 moderate-sized, bicolored, subapical spines, distal subapical spine with proximal tubercle cylindrical and longer than apical seta, second spine with tubercle conical and about equal to seta in length. *Color.* Head, collar, anterior lobe and humeral carinae of pronotum, venter of thorax, and scutellum except apex and stem of Y-shaped carina dark reddish brown, scutellar apex and stem of Y-shaped carina pale; venter of abdomen brown (sometimes slightly suffused with dark brown); remaining parts with ground color yellowish brown. Hemelytron evenly colored (or sometimes obscurely patterned with pale areas). Membrane with extremely obscure dark pattern consisting of medial V-shaped mark, a median streak from apex of V to posterior margin, a streak on each side from near apex of V running laterally and posteriorly almost to lateral margin, an obscure median oval or T-shaped spot in front of V with a white kidney-shaped spot on each side, and a streak along posterior margin of corium. Femora pale yellowish brown, subapical band imprecise and brown, apex of hind femur suffused with red, tibiae pale yellowish brown with both subbase and apex slightly darker. Antennal segments I and IV brown, suffused with much red, II and III yellowish brown with apex red. Labium yellowish brown with apex dark. Length of holotype 4.97.

Holotype male, Indonesia (Irian Jaya): Wisselmeren, Enarotadi, 1800-2000 m, VIII-2 to 6-1955, JLG. *Paratypes,* 4 males, same data as holotype; Papua New Guinea: Southern Highlands District, 1 male, Mt. Bosavi, 2300 m, V-6-1973, JLG.

Etymology: Tensus, L. for stretched or extended, referring to the relatively narrow general shape of the insect.

35. *Bryanellocoris unicolor* Chen & Ashlock, n. sp.

Head strongly deflexed, with anteocular length viewed from above much shorter than eye length (0.10:0.19); vertex slightly convex between eyes; base of vertex without median sulcus; head length 0.65, width including eyes 0.81; anteocular length 0.27, width of interocular space 0.45; eye large, not stalked, with top much higher than vertex, eye length 0.24, width 0.19; labium long, reaching hind coxae, basal segment reaching front edge of prosternum, segment lengths from base 0.51, 0.53, 0.31, 0.33; antennal segment I about 2.5 times as thick at middle as segment II, segment lengths from base 0.48, 0.87, 0.69, 0.96. *Pronotum* with collar nearly impunctate dorsally; lateral margin of anterior lobe moderately convex, callosity with about 5 fine shallow punctures in center; posterior lobe more coarsely punctate, punctures from contiguous to spaced 1 or 2 puncture diameters apart, humeral angle with dorsal tubercle inconspicuous and lateral carina blunt, rounded, and barely discernible; median length of pronotum 0.77, length of anterior lobe plus collar slightly shorter than two-thirds length of posterior lobe (0.29:0.48), width across collar 0.58, greatest width 1.41. *Scutellum* with elevated

central part of disc forming a Y-shaped carina; median length 0.75, width at base 0.74. *Hemelytron* exceeding abdomen by about two-thirds apical length of membrane; length of corium 2.26, length of claval commissure 0.48, basal length of membrane 1.03, apical length 0.99. *Thorax* ventrally with sparse, fine punctures; fore femur armed with 2 weak, bicolored, subapical spines with proximal tubercle of each spine conical and shorter than apical seta. *Color.* Whole body evenly pale. Head, collar and anterior lobe of pronotum, scutellum, and venter of thorax except acetabulae and posterior metapleural plate dark yellowish brown, acetabulae and posterior metapleural plate pale; remaining parts pale yellowish brown. Hemelytron patterned with obscure pale areas on corium at inner angle and along costal margin, and with obscure dark spots apically and along costal margin at one-quarter and two-thirds of distance from base. Membrane almost unicolored without any dark pattern except an extremely obscure streak along posterior margin of corium. Femora pale yellowish brown, nearly unicolored, subapical band obscure and light brown, tibiae pale yellowish brown with both apex and subbase slightly darker. Antenna yellowish brown, nearly unicolored, segment IV slightly darker than others. Labium pale yellowish brown with apex dark. Length of holotype 4.22.

Holotype male, PAPUA NEW GUINEA: Morobe District, Mt. Kaindi, 2350 m, V-3-1971, on *Nothofagus carri,* Tawi (native collector?).

Etymology: Unicolor, L. for of one color, referring to the relatively monochromatic general coloration.

36. *Bryanellocoris maculatus* Chen & Ashlock, n. sp.

Fig. 6I

Head slightly deflexed, with anteocular length viewed from above longer than eye length (0.26:0.21); vertex convex between eyes; base of vertex without median sulcus; head length 0.72, width including eyes 0.90; anteocular length 0.34, width of interocular space 0.60; eye moderate in size, not stalked, with top lower than vertex, eye length 0.24, width 0.17; labium long, reaching hind coxae, basal segment reaching front edge of prosternum, segment lengths from base 0.65, 0.65, 0.51, 0.41; antennal segment I about twice as thick at middle as segment II, segment lengths from base 0.42, 0.86, 0.69, 0.86. *Pronotum* with collar having small shallow punctures; lateral margin of anterior lobe moderately convex, callosity with about 7 to 9 fine punctures in center; humeral angle with dorsal tubercle inconspicuous and lateral carina blunt, rounded, and barely discernible; median length of pronotum 0.94, length of anterior lobe plus collar two-thirds length of posterior lobe (0.38:0.57), width across collar 0.75, greatest width 1.68. *Scutellum* with elevated central part of disc forming a Y-shaped carina; median length 0.96, width at base 0.87. *Hemelytron* with seta in each puncture longer than diameter of puncture; membrane exceeding abdomen by about one-third apical length; length of corium 2.61, length of claval commissure 0.58, basal length of membrane 1.20, apical length 0.86. *Thorax* ventrally with sparse punctures, seta in each puncture longer than diameter of puncture; fore femur armed with 1 (or 2; holotype varies) weak, bicolored, subapical spines with proximal tubercle of each spine conical and about equal in length to apical seta, both tubercle and seta short. *Color.* Whole body rather dark. Head, collar and anterior lobe of pronotum, central part of basal scutellum, and venter of thorax dark reddish brown; venter of thorax suffused with black; posterior lobe of pronotum yellowish brown with irregular dark spots throughout; apex of scutellum and lateral sides of basal part black, forming a large Y-shaped spot with distal apex pale yellow; venter of abdomen brown, suffused with black in large areas. Hemelytron yellowish brown, contrastingly patterned on corium with pale areas at inner angle within a yellowish brown area and along costal margin, and with blackish brown spots apically, and along costal margin at one-quarter and two-thirds of distance from base. Membrane with dark brown pattern consisting of a medial V-shaped mark, a streak along posterior margin of corium, a single median streak from apex of V to posterior margin, a short streak on each side from near apex of V running laterally and posteriorly almost to lateral margin, and a relatively obscure short streak on each side running from near anterior arm of V almost to lateral margin. Femora pale yellowish brown with definite, contrasting blackish brown basal and subapical bands, tibiae dark yellowish brown with apex and subbase blackish brown and with base pale yellowish brown. Antennal segments I and IV dark reddish brown, II and III dark yellowish brown suffused with black and with both ends dark. Labium yellowish brown, with apex dark. Length of holotype 4.37.

Holotype female, PAPUA NEW GUINEA: Morobe District, Mt. Piora, 3200 m, VI-12 to 13-1966, on *Styphelia,* JLG. *Paratypes,* PAPUA NEW GUINEA: Eastern Highlands District, 1 female, Mt. Michael, NW Arete, Saddle Camp, 3050 m, VI-18 to 22-1967, Malaise trap, GAS; Morobe District, 1 male, Wau, E Bulldog Road, 2100-

2400 m, VI-17 to 20-1976, on *Xanthomyrthus,* WCG.

Etymology: Maculatus, L. for spotted, referring to the pattern on the corium.

37. *Bryanellocoris planifrons* Chen & Ashlock, n. sp.

Head strongly deflexed, with anteocular length viewed from above much shorter than eye length (0.12:0.22); vertex flat between eyes; base of vertex without median sulcus; subshining both dorsally and ventrally; head length 0.69, width including eyes 0.96; anteocular length 0.27, width of interocular space 0.53; eye large, not stalked, with top much higher than vertex, eye length 0.25, width 0.21; labium long, reaching hind coxae, basal segment far exceeding front edge of prosternum, segment lengths from base 0.69, 0.62, 0.34, 0.34; antennal segment I about twice as thick at middle as segment II, segment lengths from base 0.57, 0.99, 0.72, 1.03. *Pronotum* with collar having a few punctures dorsally; lateral margin of anterior lobe moderately convex, callosity with about 7 to 9 small punctures in center; humeral angle with dorsal tubercle inconspicuous and lateral carina blunt, rounded,

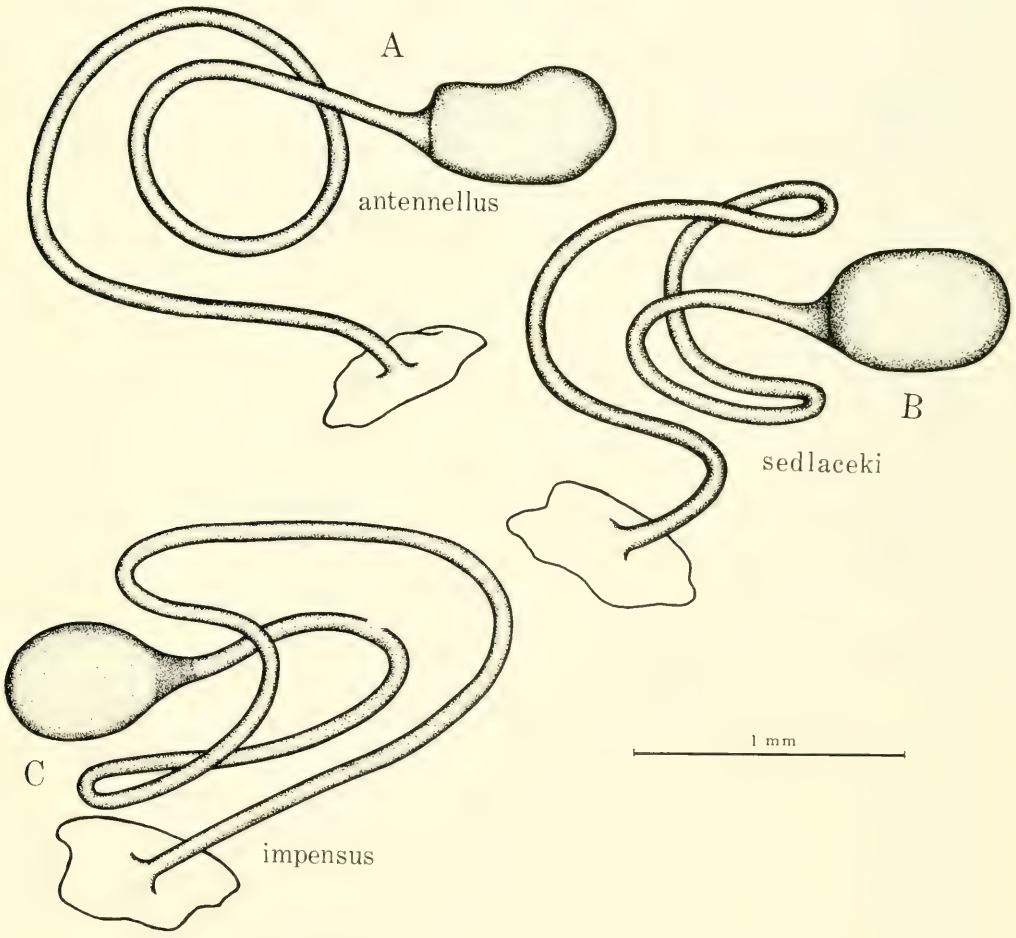

FIG. 9. Spermathecae of named species of *Bryanellocoris.*

and barely discernible; median length of pronotum 1.03, length of anterior lobe plus collar less than one-half length of posterior lobe (0.29:0.74), width across collar 0.70, greatest width 1.78. *Scutellum* with elevated central part of disc forming a Y-shaped carina; median length 0.99, width at base 1.06. *Hemelytron* exceeding abdomen by about one-half apical length of membrane; length of corium 2.85, length of claval commissure 0.58, basal length of membrane 1.30, apical length 1.23. *Thorax* ventrally with sparse, small punctures, seta in each puncture longer than diameter of puncture; fore femur armed with 2 bicolored, subapical spines with proximal tubercle of each spine conical and about equal in length to apical seta. *Color.* Whole body rather dark. Head, collar and anterior lobe of pronotum very dark reddish (nearly blackish) brown; basal two-thirds of scutellum and venter of thorax except acetabulae and posterior metapleural plate dark reddish brown, acetabulae and posterior metapleural plate pale; posterior lobe of pronotum yellowish brown with a large irregular black spot on each side covering anterior part of posterior lobe and almost all callosity of anterior lobe; apical portion of scutellum black with apex pale yellowish brown; venter of abdomen with basal three-fifths reddish brown and apical two-fifths yellowish brown with a broad black streak on each lateral side. Hemelytron yellowish brown, patterned with pale areas on clavus near apex and on corium at inner angle, each within a large dark area, and pale along costal margin, and with blackish brown spots apically, and along costal margin at one-quarter and two-thirds of distance from base. Membrane nearly unicolored except for an extremely obscure dark streak along posterior margin of corium and a medial V-shaped mark. Femora pale yellowish brown with subapical band dark brown, tibiae yellowish brown with apex and subbase dark brown. Antennal segments I-III yellowish brown suffused with black, II and III with both ends dark, segment IV reddish brown. Labium yellowish brown, with apex dark. Length of holotype 5.08.

Holotype female, PAPUA NEW GUINEA: Morobe District, Wau, E Bulldog Road, 2100-2400 m, VI-17 to 20-1976, WCG.

Etymology: Planifrons, L. for flat frons, in reference to the flat vertex of the head.

38. *Bryanellocoris gagnei* Chen & Ashlock, n. sp.

Fig. 5I

Head moderately deflexed, with anteocular length viewed from above much shorter than eye length (0.14:0.23); vertex flat between eyes; base of vertex without median sulcus; head length 0.65, width including eyes 0.84; anteocular length 0.24, width of interocular space 0.45; eye large, not stalked, with top much higher than vertex, eye length 0.24, width 0.20; labium long, reaching hind coxae, basal segment far exceeding front edge of prosternum, segment lengths from base 0.55, 0.51, 0.34, 0.34; antennal segment I about twice as thick at middle as segment II, segment lengths from base 0.51, 0.93, 0.67, 0.89. *Pronotum* with collar having sparse small punctures; lateral margin of anterior lobe moderately convex, callosity with about 10 fine punctures in center; humeral angle with dorsal tubercle inconspicuous and lateral carina blunt, rounded, and barely discernible; median length of pronotum 0.89, length of anterior lobe plus collar slightly less than one-half length of posterior lobe (0.27:0.62), width across collar 0.62, greatest width 1.48. *Scutellum* with elevated central part of disc forming a Y-shaped carina but with stem inconspicuous; median length 0.79, width at base 0.82. *Hemelytron* exceeding abdomen by about one-half apical length of membrane; length of corium 2.33, length of claval commissure 0.51, basal length of membrane 1.10, apical length 1.03. *Thorax* ventrally with sparse, small punctures, seta in each puncture longer than diameter of puncture; fore femur armed with 2 weak, bicolored, subapical spines with proximal tubercle of each spine conical or slightly cylindrical and about equal in length to apical seta. *Color.* Head, collar and anterior lobe of pronotum, base of scutellum, and venter of thorax except acetabulae and posterior metapleural plate dark reddish brown, acetabulae and posterior metapleural plate pale; posterior lobe of pronotum yellowish brown; pronotum with an irregular black spot on each side covering anterior part of posterior lobe and part of callosity of anterior lobe (spot sometimes absent or expanded nearly to cover anterior lobe); apical one-third of scutellum black with apex pale yellowish brown; venter of abdomen dark yellowish or reddish brown, apical two-fifths with a broad obscure black streak on each lateral side (sometimes absent). Hemelytron yellowish brown with pale areas on clavus near apex and on corium at inner angle, each within a large dark area, and along costal margin, and with dark spots apically, and along costal margin at one-quarter and two-thirds of distance from base. Membrane with obscure dark pattern consisting of a medial V-shaped mark, a streak along posterior margin of corium, a median streak running from apex of V almost to posterior margin, and a streak on each side from near middle of each arm of V almost to lateral margin. Femora pale

yellowish brown, subapical band brown, narrow and imprecise, tibiae yellowish brown with both apex and subbase from light brown to dark brown. Antennal segment I dark brown, II and III yellowish brown with both ends dark, segment IV yellowish brown (or reddish). Labium pale yellowish brown with apex dark brown. Length of holotype 4.32.

Holotype male, Papua New Guinea: Morobe District, Wau, Mt. Kaindi, 2360 m, III-26-1977, light trap, WCG. *Paratypes,* 16 males, 10 females, same data as holotype; Papua New Guinea: Madang District, 2 females, Finisterre Range, Saidor, Kiambavi Village, VII-22 to 29-1958, near Freyberg Pass (N), 2550, X-1 to 21-1958, WWB, 1 male, main Finisterre Range near Freyberg Pass (N), 2550 m, X-1 to 21-1958, WWB; Morobe District, 8 males, 11 females, Wau, Mt. Kaindi, 2360 m, XII-11-1976, IV-29-1977, light trap, WCG, II-19 to 20-1977, XII-3-1977, light trap, WCG, 2350 m, II-8-1971, on *Nothofagus carri,* III-24-1966, JLG, 2350 m, IV-7-1966, JL&MG, 1 male, Wau, 1200 m, VII-24-1961, light trap, JS, 1 male, 3 females, Salawaket Range, Sepalakembang, 1920 m, Baindoang, 1800 m, IX-9 to 15-1956, light trap, BJFJr, 3 males, 2 females, Bulldog Road, 2400-2900 m, VI-17 to 20-1978, WCG; Indonesia (Irian Jaya): 1 female, Wisselmeren, Enarotadi, 1800 m, VII-5-1955, light trap, JLG; 1 male, Vogekop, Sururai Village, SW Lake Anggi Giji, 2000-2100 m, III-4 to 5-1963, B. Straatmann.

Etymology: Named for W. C. Gagné of the Bishop Museum, Honolulu, Hawaii.

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THE UNIVERSITY OF KANSAS
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Systematics and Phylogeny of the Anthophorine Bees (Hymenoptera: Anthophoridae; Anthophorini)

By
Robert W. Brooks

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Professor Charles Duncan Michener

this study is dedicated
in anticipation of the
occasion of his seventieth birthday
22 September 1988
and his retirement
from the departments of Entomology
and Systematics and Ecology
18 May 1989

THE UNIVERSITY OF KANSAS
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ABSTRACT

The genera and subgenera of the cosmopolitan tribe Anthophorini are reviewed. Genera and subgenera are separated by keys, are described, included species are listed and pertinent morphological features illustrated. Two monophyletic genera are recognized. (1) *Anthophora* consists of 14 subgenera of which the following seven are new: *Pyganthophora* (type species, *Apis retusa* L.), *Lophanthophora* (type species, *Anthophora porterae* Ckll.), *Petalosternon* (type species, *Anthophora rivolleti* Pérez), *Dasymegilla* (type species, *Apis quadrimaculata* Panzer), *Rhinomegilla* (type species, *Anthophora megarrhina* Ckll.), *Caranthophora* (type species, *Anthophora dufourii* Lep.), *Mystacanthophora* (type species, *Anthophora montana* Cress.) and (2) *Amegilla* consists of 11 subgenera of which seven are new: *Megamegilla* (type species, *Apis acraensis* Fab.), *Ackmonopsis* (type species, *Anthophora mimadvena* Ckll.), *Micramegilla* (type species, *Anthophora niveata* Friese), *Glossamegilla* (type species, *Anthophora mesopyrrha* Ckll.), *Notomegilla* (type species, *Anthophora aeruginosa* F. Smith), *Zebramegilla* (type species, *Anthophora albigena* Lepeletier) and *Dizonamegilla* (type species, *Megilla sesquicincta* Erichson and Klug). *Solamegilla* Marikowskaya is placed as a synonym of *Paramegilla* Friese and *Micranthophora* Cockerell as a synonym of *Heliophila* Klug. New species described are *Anthophora (Anthophoroides) signata, A. (Anthophoroides) phaceliae, A. (Mystacanthophora) bahamensis, A. (Mystacanthophora) boharti, A. (Caranthophora) spinacoxa, A. (Heliophila) joetta, A. (Heliophila) micheneri, A. (Pyganthophora) adamsorum; Amegilla (Micramegilla) canifronoides, A. (Micramegilla) capeverdensis, A. (Micramegilla) modestoides, A. (Glossamegilla) lieftincki, A. (Aframegilla) elsei, A. (Aframegilla) robinae, A. (Megamegilla) paradoxa, A. nonconforma, A. (Asaropoda) epaphrodita and A. (Asaropoda) houstoni.* Probable cladistic relationships are given at the tribal, generic and subgeneric levels. A biogeographical discussion of subgeneric groups is included. See Appendix 2 for lectotypic and neotypic designations, and Appendix 3 for newly recognized homonymy, new synonymy, a list of all names that have been applied to species and subspecies of Anthophorini and Habropodini, and an index to specific names. In addition the genus *Emphoropsis* is synonymized under the now holarctic and oriental genus *Habropoda.*

INTRODUCTION

This study provides a classification and proposes a phylogeny for the genera and subgenera of anthophorine bees. The tribe Anthophorini, worldwide in distribution, and considered here to include only two genera, *Anthophora* and *Amegilla,* is distinguished from other Anthophorinae by three submarginal cells, the first recurrent vein meeting the posterior margin of submarginal cell 2 near its midpoint, the forewing with simple alar papillae, the second abcissa of vein M + Cu of the hind wing subequal in length to the cu-v crossvein, and the elongate, narrow gonostylus (if present) never flattened and paddle shaped. The Habropodini consisting of *Deltoptila, Elaphropoda, Habropoda (= Emphoropsis* **n. syn.**), *Habrophorula* and *Pachymelus,* and formerly included in the Anthophorini, are as distinct from the Anthophorini as the Emphorini are from the Eucerini.

Anthophorine bees are mainly xerophilic and abundant in Mediterranean climates. Among the North American species over 90% occur in the dry southwest. In the Old World, where most anthophorine bees occur, the most speciose area is the Mediterranean Region. Of the 14 subgenera of *Anthophora* eight are found in the New World; only one is restricted to that area. They are scarce in tropical forests but are often found in tropical montane environs. *Amegilla* is strictly Old World and flies in the summer, while *Anthophora* is worldwide in distribution and commonly flies in the spring.

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Mick C. Day of the British Museum (Natural History) and Astrid Løken of the Zoological Institute of Blindern, Norway, brought to my attention many overlooked details concerning the identity of *Apis acervorum* Linneaus.

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HISTORICAL REVIEW

The following review deals only with major steps in establishment of the supraspecific taxa and classification. The systematic history of each genus and subgenus is associated with its description and is only mentioned briefly here. Because of the similarity of Habropodini and Anthophorini, most authors have either confused them or regarded them as a single tribe. Therefore the Habropodini are included in the subsequent paragraphs.

Linneaus described the first anthophorine bee as *Apis retusa* (1758). In the same work he also described *Apis acervorum,* which he first mentioned in 1746 and was thought by subsequent workers to be an anthophorine bee after being misidentified by Fabricius (1775). Not until recently, however, was it discovered that *A. acervorum* probably was a bumble bee (Day, 1979; Løken, 1973; see *Comments* under *Anthophora* s. str.). The second genuine anthophorine species described was *Apis plumipes* Pallas (1772), which is conspecific with the *A. acervorum* of Fabricius and with *A. pilipes* Fabricius (1775). Latreille described the first anthophorine genus, *Podalirius,* in 1802b but this name was suppressed (Hemming, 1944) by the International Commission on Zoological Nomenclature (ICZN). Latreille proposed *Anthophora* (1803) as a replacement for *Podalirius* on the ground that the latter was preoccupied in plants. *Anthophora* became the type genus for the tribe, subfamily and family. Fabricius named a genus *Megilla* [1805] which originally included species that we now recognize to be in the Hylaeinae (Colletidae), Halictinae and Nomiinae (Halictidae), Melittinae (Melittidae), Exomalopsini, Habropodini and Anthophorini (Anthophoridae), and the Bombini (Apidae). The name *Megilla* is now regarded as a junior synonym of *Anthophora* (Michener, 1984).

Latreille (1802a) proposed the group Podalirii based on the genus *Podalirius.* Dahlbom in 1835 placed *Anthophora* in his tribe Anthophorini. Once *Podalirius* was suppressed by the ICZN (Hemming, 1944) to conserve the name *Anthophora,* it was no longer available as the type genus for a higher categorical name and Dahlbom's tribal name became valid (see Michener, 1986).

A historical review of developments at the generic and specific levels will be found in Brooks (1986).

METHODS

I have sought to examine every species and have been able to see over 90% of the described species in the Anthophorini and Habropodini. Types were studied from al-

most all major collections as well as determined and undetermined material in these collections so that as many species as possible could be placed in their appropriate groups. I have attempted to make known the unusual as well as common attributes of anthophorine species so as to facilitate future revisionary studies of the various groups at the specific level.

All structures which could be studied flattened, such as sterna, were placed on slides in glycerine for illustrative purposes. Larger structures such as the genital capsule and mouthparts were dissected and studied in either alcohol or glycerine. Terminalia and mouthparts were cleared overnight at room temperature in about 10% KOH and then transferred to one or two changes of water for several hours (sometimes acidulated water), finally to glycerine for study and long-term preservation.

Preparation of specimens for scanning electron microscopy entailed initial relaxing in a humidifier for one to two days. Parts were taken from the specimens and ultrasonicated in three warm baths (five minutes each): the first, water with a detergent; then 70% alcohol; and finally, xylene. The structures, if relatively hairless, were allowed to air dry; if hairy they were dried with air blown through a piece of surgical tubing attached to a micropipette. The specimens were then mounted with glue (casein) on stubs coated with Tubekote® so as to give a uniform black background. Specimens were coated with 200 Å of gold-palladium and scanned with 15 Kv (200 spot size), using a Phillips 501 scanning electron microscope.

Morphological terminology follows for the most part Michener (1944) and for mouthparts, in certain cases, Winston (1979). New terms for structures are explained in the section on *Characters Employed.* The proboscis is regarded as projecting downward from the head. Thus the anterior surface of the mentum is the surface that would be called dorsal if the proboscis were considered to project forward. To save space the metasomal segments are abbreviated S for sternum and T for tergum. Therefore sternum 6 is termed S6 and tergum 6 is T6, etc. Almost all Anthophorini have bidentate mandibles and apically simple labra, thus only exceptions to these are listed. All capitalized colors are from Ridgway (1912) except dark browns and other nonspecific generalized terms (e.g., dark brown, ferruginous, amber.) All characters of surface sculpture are described using the system of Harris (1979) and were examined under fiber-optic illumination diffused by frosted drafting film to eliminate reflections.

Illustrations of terminalia and mouthparts were drawn from cleared material using a drawing tube. On shaded drawings the light was positioned so as to strike the subject from the upper left. For figures of the upper (anterior) views of maxillae, the whole maxilla was slightly flattened under a coverslip. The orientation of the lacinia and penis are not standardized and thus their shapes are not meaningful.

Comments on distributions were prepared from data taken from specimens and almost always not from the literature, because there are many misidentifications in the latter.

The generic and subgeneric descriptions take into account all characters described in the *Characters Employed* section and follow the same lettering system to facilitate comparisons. That is, the characters of the genera are directly comparable, and the characters of the subgenera within a genus are comparable, but not the characters of subgenera of different genera. Major as well as minor trends of variation are noted in the descriptions. When one or a small group of species differed from the majority in a character, the differences and species involved are indicated in parentheses. Structures which are described without indication of sex pertain to both sexes.

Genital capsules were drawn with left and right sides illustrating the dorsal and ventral surfaces respectively. Dashed lines represent hidden internal structures, while dotted lines indicate ridges or denote areas of dark sclerotization. Dot matrices represent the penis and other membranes of the genital capsule.

Type depositories of new species described in Appendix 1 are indicated within brackets, according to the following list: [Ansfelden], Austria, Collection of M. Schwarz; [Berkeley], University of California; [Budapest],

Hungarian Natural History Museum; [Berlin], Museum fur Naturkunde, Humboldt-Universität; [Buenos Aires], Museo Argentino de Ciencias Naturales "Bernardino Rivadavia"; [Cambridge], Museum of Comparative Zoology; [Canberra], Australia, C.S.I.R.O.; [Copenhagen], Zoologisk Museum; [Davis], University of California; [Eberswalde], Deutsches Entomologisches Institut; [Frankfurt], Forschungsinstitut Senckenberg; [Geneva], Muséum d'Histoire Naturelle; [Genoa], Museo Civico di Storia Naturale; [Lawrence], Snow Entomological Museum, University of Kansas; [Leiden], Rijksmuseum van Natuurlijke Historie; [Lenigrad], Zoological Institute, Academy of Sciences of the U.S.S.R.; [Logan], Bee Biology and Systematics Laboratory, Utah State University; [London], British Museum (Natural History); [Los Angeles], Natural History Museum of Los Angeles County; [Moscow], Zoological Museum, Moscow State University; [Ottawa], Biosystematics Research Institute; [Paris], Muséum National d'Histoire Naturelle; [Perth], Western Australia Museum; [Pretoria], Transvaal Museum; [Pullman], Washington State University; [Riverside], University of California; [San Francisco], California Academy of Sciences; [Turin], Museo ed Istituto di Zoologia Sistematica; [Urbana], Illinois Natural History Survey; [Vienna], Naturhistorisches Museum; [Washington], National Museum of Natural History.

Cladistic analysis was aided by the computer program PAUP (Swofford, 1984). The methodology, based on parsimony, is the same as that followed by Snelling and Brooks (1985). The outgroups for the Anthophorini were the Habropodini and the rest of the Anthophorinae. In this study the expression "anthophorine bees" refers to bees of the tribe Anthophorini. Tables 1 and 3 include notes on the distribution of characters of the variables and the bases for my judgments of polarity (evolutionary direction). Discussion is frequently abbreviated but is sufficient to suggest reasons for my decisions. Tables 2 and 4 contain the data used to construct the cladograms. When a character is not constant within a taxon it is shown as P in Tables 2 and 4. In such cases the plesiomorphous state was used in the analysis.

Appendix 1 contains descriptions of new species referred to in the body of the text. Appendix 2 is lectotypic and neotypic designations and Appendix 3 is a list of species-group names indicating present generic assignments, synonymies, new combinations in the Habropodini (a few in the Eucerini), clarification of certain nomenclatural problems, and an index (the last entry under each name within parentheses and bold face is the page number or page numbers where that name is referred to in the text). The text contains new combinations of Anthophorini.

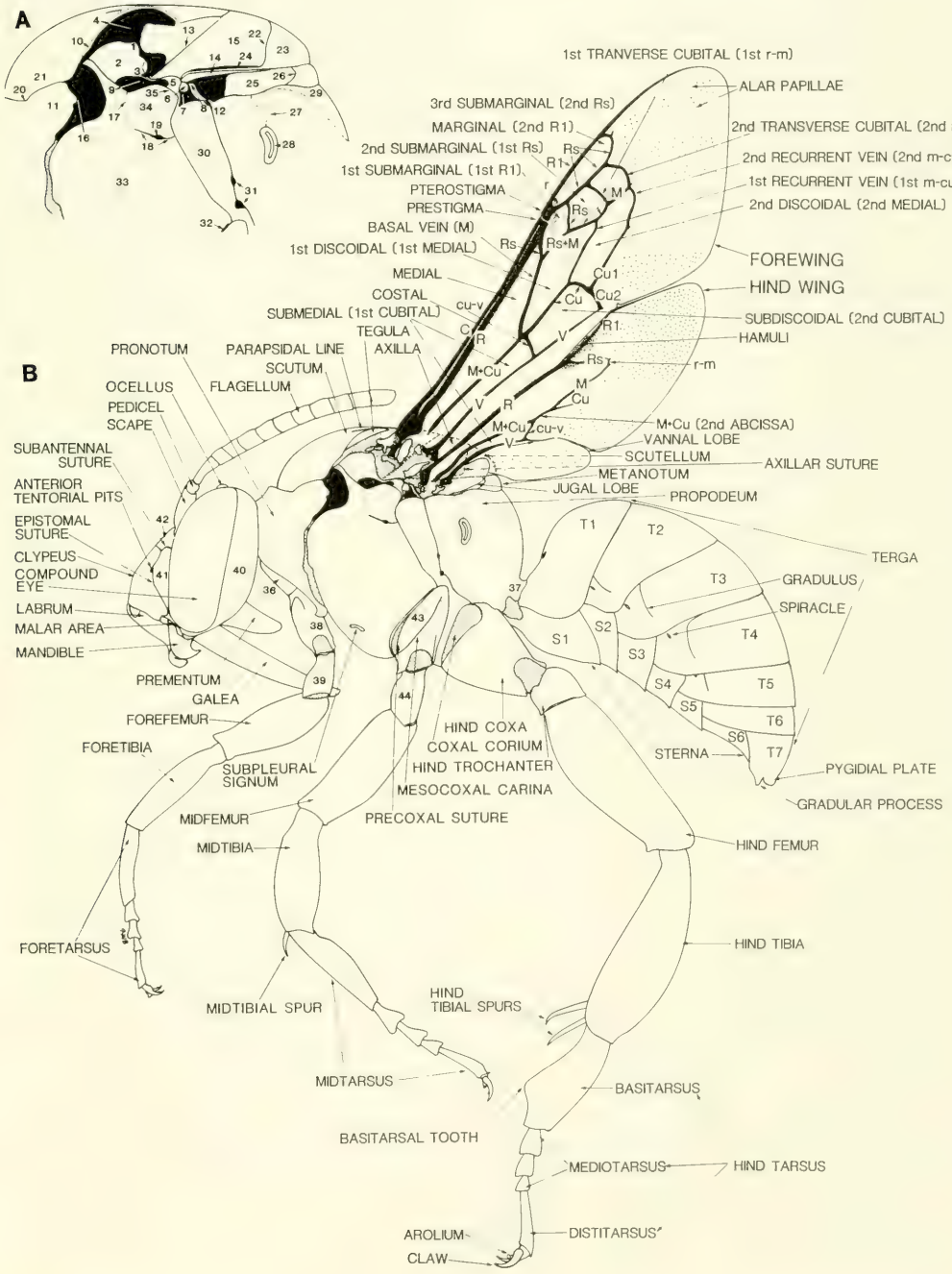
CHARACTERS EMPLOYED

From the great number of possible characters, I selected those that showed discrete differences among the taxa and were more or less invariable in at least certain taxa. Of course this is a circular process since the taxa are recognized on the basis of the more or less invariable characters. Recognition of taxa on largely or wholly phenetic bases, however, is an essential prelude to further analysis.

I have attempted to find easily observed external characters but unfortunately most of the distinctive group characters were

FIG. 1. A, Side view of *Anthophora (Paramegilla) centriformis* male with hair omitted; upper two-thirds of thorax with wing removed. B, Complete side view. 1. Tegular articulation. 2. Subalar area. 3. Anterior metanotal wing process. 4. Preaxilla. 5. Mesepimeron. 6. Peritreme. 7. Metaspiracle. 8. Pleural wing process. 9. Subalar pit. 10. Supra-alar carina. 11. Pronotal lobe. 12. Metapleural suture. 13. Transscutal suture. 14. Scutellar crest. 15. Axilla. 16. Mesospiracle. 17. Pre-episternal suture. 18. Scrobal suture. 19. Episternal scrobe. 20. Anterolateral angle of scutum. 21. Anterolateral process. 22. Axillar suture. 23. Scutellum. 24. Axillar fossa. 25. Dorsolateral metanotal area. 26. Transmetanotal suture. 27. Spiracular suture. 28. Propodeal spiracle. 29. Propodeal triangle. 30. Metepisternum. 31. Metapleural pits. 32. Mesokatepisternum. 33. Mesepisternum. 34. Hypoepimeral area. 35. Mesopleural suture. 36. Propleuron. 37. Marginal area of propodeum. 38. Forecoxa. 39. Foretrochanter. 40. Genal area. 41. Paraocular area. 42. Supraclypeal area. 43. Midcoxa. 44. Midtrochanter.

found in the male terminalia and mouthparts, therefore requiring dissections. Anthophorine females have proven difficult to separate and to place in groups; for the most part, the subgeneric groups of Anthophorini are based on characters of males. The sting apparatus was remarkably consistent among the taxa and not found useful for placing females in groups. The mouthparts and genitalia were dissected for almost all described species as well as many undescribed ones. The measurements reflect the variation



found in all species of a taxon, but often only a single specimen of each species was dissected. Nonetheless, the study of genitalia and mouthparts of individuals of a few common species and of as many species of each subgenus as were available shows that these characters are quite constant.

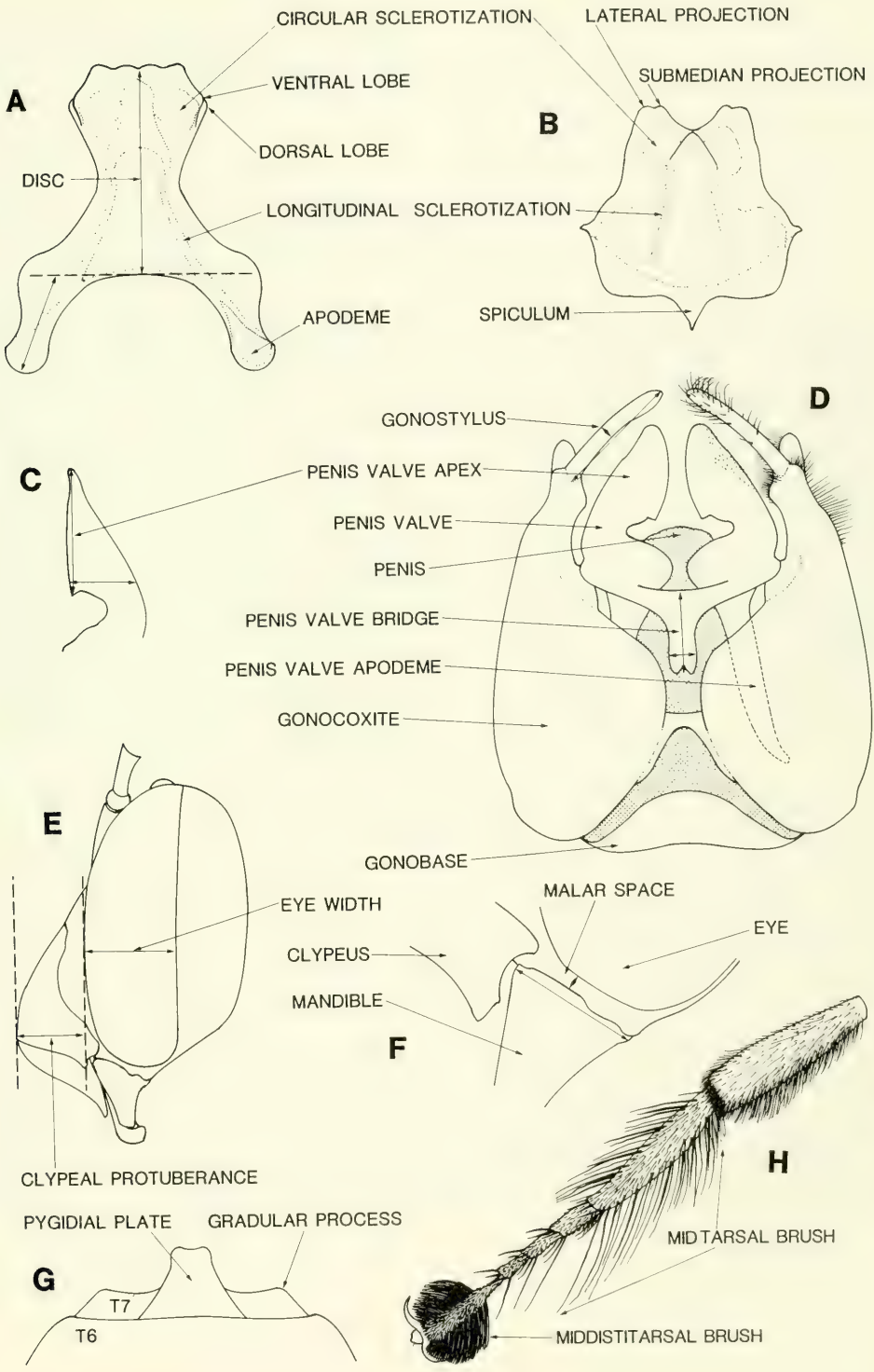
The subgeneric classification of *Anthophora* presented in the next section is based on the lettered groups of characters listed below. This list serves to explain the terminology used in keys and descriptions.

Head. (a) The flagellomeres were measured from lateral view along their midlines. The length of *flagellomere 1* relative to the succeeding flagellomeres is especially useful to separate females. Some subgenera are characterized by a long first flagellomere which equals in length the next four to five or more flagellomeres (Fig. 7a). Other subgenera have a short first flagellomere, equaling in length only the next two to three together (Fig. 7b). (b) Pale *integumental facial markings* are almost always present in male Anthophorinae and females of *Amegilla,* but are rare in female *Anthophora.* The *mandible* almost always has a subapical tooth. (c) The *malar space* normally is linear (Fig. 2f), that is, four to five or more times as wide as long. In bees with a strongly protuberant clypeus and long mouthparts, however, the malar space is often prolonged (Figs. 25h, 26c), sometimes as much as twice as wide as long. The method for measurement of the clypeal protuberance compared to the eye width is shown in Figure 2e. The glossal *flabellum* has long finger-like apical lobes (Fig. 16b) in almost all *Amegilla* and most *Anthophora.* In some subgenera of *Anthophora,* however, the shape of the flabellum is diagnostic, being more elongate with numerous short apical lobes (Fig. 26b) or apically entire (Figs. 12j, 25d). In almost all *Anthophora* the mentum is simple without an anterior tooth on the basal third, but the subgenus *Melea* (Fig. 22k), a species of *Dasymegilla,* and almost all *Amegilla* (except *A. nonconforma* n. sp.) have that tooth.

Thorax. (d-f) Some male *Anthophora* have three kinds of pubescent fringes or "brushes" of hair on their midlegs (Fig. 12c). The *midbasitarsal brush* is a dense patch of short black pubescence on the anterior apical surface of the basitarsus. The *midtarsal brush* is a long loose fringe of pale to dark hair on the posterior surfaces of tarsomeres 1-4. The "fan" or fringe of black hair on the lateral margins of the distitarsus is the *middistitarsal brush.* (g) The *hind basitarsus* of males is usually unmodified, but sometimes a basal to apical tooth is present on the anterior surface (Figs. 20j, 20o). Occasionally the *hind tibia* has an apical spine on its anterior surface (Fig. 41e), the outer tibial spur being inserted on the spine in various positions. The hind tibial *scopa* of females consists of simple hairs on the outer surface of the hind tibia. The *posterior margin of the hind tibia* is the narrowed rear area of the hind tibia from its base to apex. The hairs on the posterior margin of the hind tibia of *Anthophora* are simple, like the rest of the tibial scopa, in some subgenera (Figs. 10e, 22h) but plumose, in contrast to the rest, in most. (h) The *basitibial plates* are present in all females and many male anthophorine bees. They are small, roughened and devoid of hair when present in the males.

Metasoma. (i) *S6* of male is usually apicomedially emarginate (Figs. 13a, 16f, 18f) and generally covered sparsely with plumose hair. Its apodemes have well developed apical processes. The ventral surface is modified in various ways such as by protuberances, depressions and ridges. (j) *S7* of male usually has long apodemes. The method of finding the ratio of the length of the apodeme to the length of the disc is shown in Figure 2a. The apex of the sternum is variously modified. The lateral margin can have a *ventral lobe* and proximal to it a *dorsal lobe;* medial to the lobes there may be a lightly sclerotized area, the *circular sclerotization,* and running longitudinally, a darkened line, the *longitudinal sclerotization* (Fig. 2a). (k) *S8* of male is apically narrow to broad. Sometimes on the apicolateral corner there may be two lobes, the *submedian projection* and the *lateral projection,* as well as longitudinal sclerotizations (Fig. 2b). The *spiculum* is always present, usually dorsally directed (Fig. 24h). In one subgenus of *Anthophora* the spiculum is long and anteriorly directed, more or less in the same plane as the disc (Fig. 25b). (l) The *apex of the gonocoxite* of the male is heavily sclerotized and variously modified with one to three lobes. It always bears setae,

FIG. 2. Morphological terms and measurements. Hair omitted in E and G. A-D, G, H, *Anthophora (Pyganthophora) crotchii* male; E, F, *A. (Paramegilla) centriformis* male. A, S7, ventral view, showing how length of disc and apodeme were measured. B, S8, ventral view. C, Dorsoapical view of apex of penis valve, measurement shown of length/width ratio. D, Genital capsule, dorsal view. E, Head, side view, showing how clypeal protuberance/eye width ratio was measured. F, Ocular mandibular area, showing how length of malar space was determined. G, Apex of male metasoma, dorsal view. H. Midleg, outer view.


A
CIRCULAR SCLEROTIZATION
VENTRAL LOBE
DORSAL LOBE
DISC
LONGITUDINAL SCLEROTIZATION
APODEME
B
LATERAL PROJECTION
SUBMEDIAN PROJECTION
SPICULUM
C
PENIS VALVE APEX
D
GONOSTYLUS
PENIS VALVE
PENIS
PENIS VALVE BRIDGE
PENIS VALVE APODEME
GONOCOXITE
GONOBASE
E
EYE WIDTH
CLYPEAL PROTUBERANCE
F
MALAR SPACE
EYE
CLYPEUS
MANDIBLE
G
PYGIDIAL PLATE
GRADULAR PROCESS
T7
T6
H
MIDTARSAL BRUSH
MIDDISTITARSAL BRUSH

usually plumose ones. (m) Each gonocoxite bears only a single, narrow, usually elongate *gonostylus* which is always setose and almost always only slightly sclerotized. Sometimes it is reduced to a blister or is lost. Figure 2d demonstrates how I measure the length and width of the gonostylus. (n) The *penis valve apex* is gently rounded, never with an apical crest, and always bears minute setae on its dorsal surface. Viewing the apex apicodorsally, the length is measured along the inner margin and the width is taken at a 90 degree angle to the length, measuring at the base of the penis valve apex (Fig. 2c). (o) The *penis valve bridge* (its measurement shown in Fig. 2d) is usually basally emarginate. In one subgenus of *Anthophora,* however, the bridge is basally acute, and in another almost absent. (p) The male *pygidial plate* (Fig. 2g) is often present. Just as often the apex of T7 bears two submedian teeth and lacks a pygidial plate (Fig. 18j). Occasionally the gradulus of the male T7 is prolonged laterally into a gradular process, which can be blunt (Fig. 2g) to acute (Fig. 30g). A *gradular process* may also be present on T6 and rarely on T5. (q) Usually

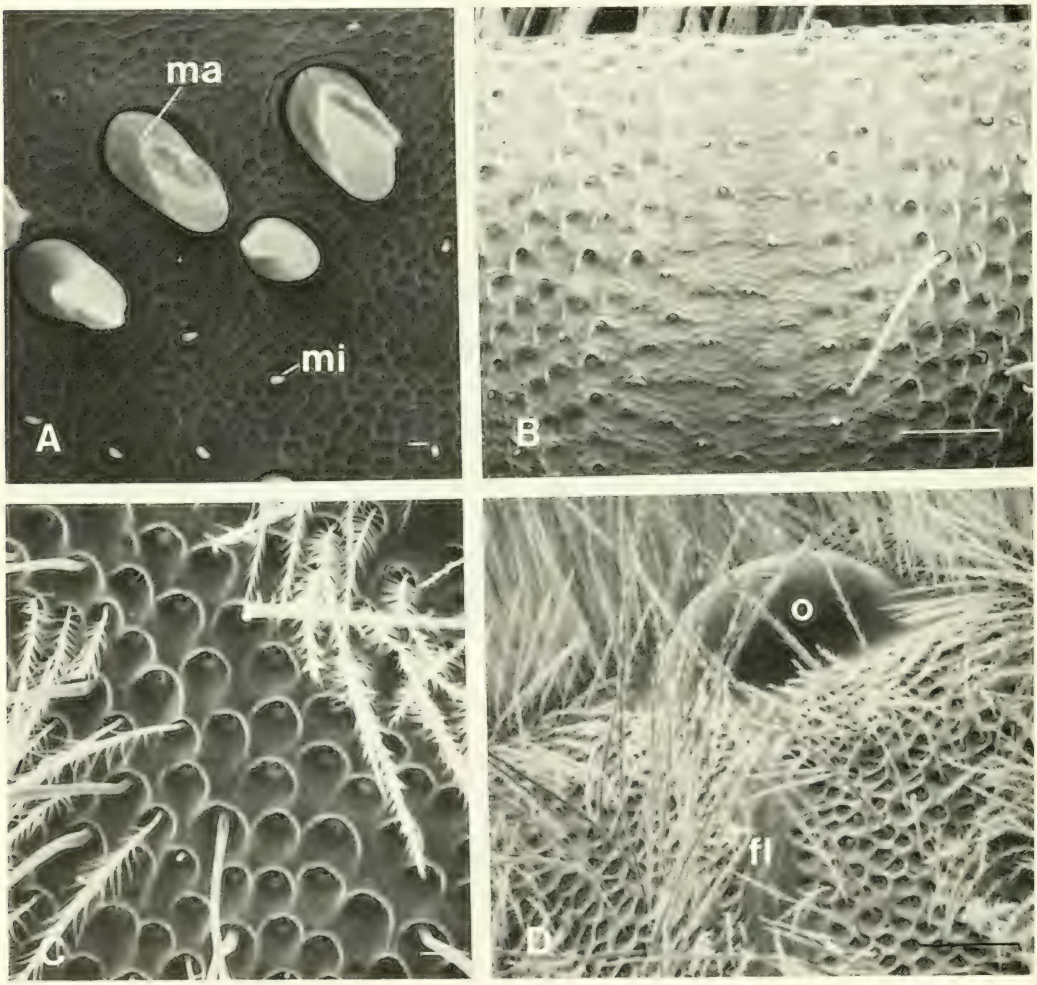


FIG. 3. Sculpturing commonly found in anthophorine bees. Scale line represent .01 mm in A and C, .1 mm in B and D; ma = macroseta, mi = microseta, fl = frontal line, o = median ocellus. A, *Anthophora (Mystacanthophora) incerta* female, clypeus with microareolate sculpturing. B, *A. (Heliophila) vestita* female, vertex of head (with hairs broken off) showing punctate sculpturing laterally grading into puncticulate medially, ground between punctures microareolate. C, D, *A. (Heliophila) bimaculata* male, supraclypeal area showing punctate-reticulate sculpturing, and ocellar region with rugulose-lacunose sculpturing shown on either side of frontal line.

the *first recurrent vein* of the forewing joins submarginal cell 2 at or slightly distal to the midpoint on the posterior margin of the cell. It is never interstitial with the first transverse cubital vein (Fig. 4a). (r) The *sting* is 2-3 times longer than the gonostylus.

Body length is measured in dorsal aspect from the apex of the clypeus to the apex of the metasoma; it is 6-24 mm.

TRIBE ANTHOPHORINI DAHLBOM

Podalirii Latreille, 1802a, p. 377.
Anthophorini Dahlbom, 1835, p. 5.
Megillina Thomson, 1869, p.7.

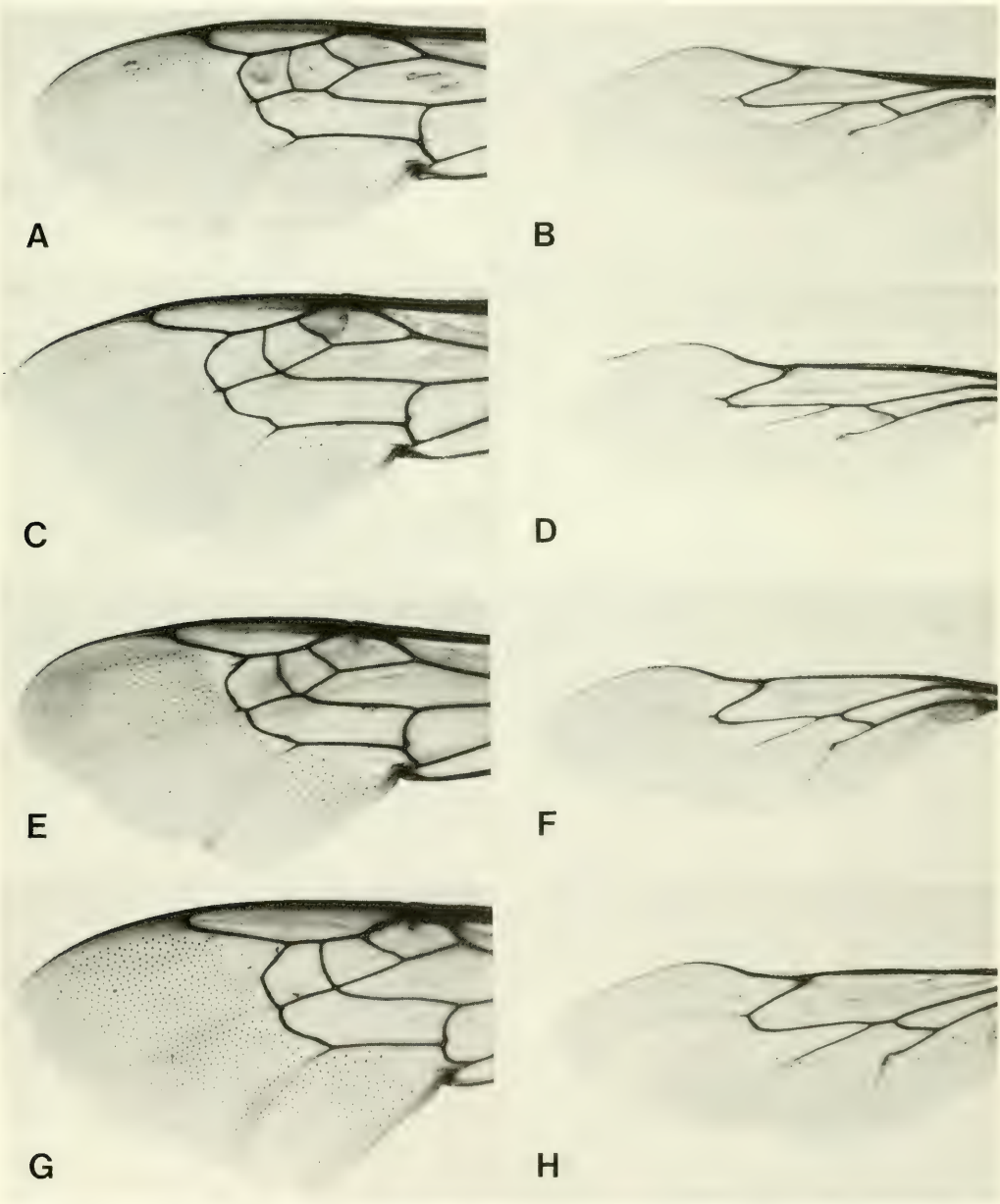


FIG. 4. Fore (A, C, E, G) and hind wings (B, D, F, H) of anthophorine and habropodine bees. A, B, *Anthophora plumipes*. C, D, *Habropoda tarsata*. E, F, *H. tristissima*. G, H, *Pachymelus conspicuus*.

Diagnosis. Bees of small to large size, differing from Habropodini as follows: first recurrent vein joining posterior margin of submarginal cell 2 near midpoint, never interstitial with vein between submarginal cells 2 and 3 (Fig. 4a); anterior and posterior margins of submarginal cell 3 more nearly equal in length; marginal cell short, shorter than combined lengths of submarginal cells along their posterior margins (Fig. 4a); spatha absent; gonostylus of male never paddle shaped, one gonostylus per gonocoxite; apex of S7 of male never pointed but entire to emarginate; S6 of male not strongly convex medioapically; scopal hair simple except on posterior margin of hind tibia usually plumose (Figs. 10a-c), sometimes simple (Fig. 10d-e).

Description. a. Body length 6.0-24.0 mm. b. Flagellar segment 1 of female equal to combined lengths of next 2.0-5.5 flagellomeres; of male, to next 1.0-4.2 flagellomeres. c. Face of male almost always with white to yellow integumental markings, rarely all black; face of female with or without white to yellow integumental marking; mandible almost always with subapical tooth; clypeus protuberant to relatively flat, profile projecting 0.3-1.2 width of eye; labrum usually apically simple, margin thickened; maxillary palpus usually with six segments, sometimes five or four; labial palpus almost always with four segments, sometimes three or two; mentum usually without a pair of teeth on anterior basal third, length 0.5-0.9 length of prementum; paraglossal length equal to 0.5-1.2 length of stipes; lorum almost always Y-shaped. d. Malar space of male and female 1.0- 16.0 times wider than long. e. Midtibia of male sometimes with various brushes of hair (Figs. 12c, 13j, 18k). f. Hind basitarsus of male sometimes with tooth, ridge, and/or swollen; hind tibia of female with simple scopal hairs, though usually with a narrow posterior longitudinal zone of plumose hair. g. Arolia present except in *Amegilla.* h. Basitibial plate of male present to absent. i. S6 of male generally flat except for lateral margin, medioapically emarginate to entire, rarely produced, disc variously modified with depressions, protuberances, or ridges; S4 and 5 of male usually normal, rarely modified. j. S7 of male with disc apically emarginate to bluntly produced, laterally simple or with one to two lobes, length of apodeme 0.24-1.75 length of disc. k. S8 of male apically narrow to broad, with two small submedian lobes whose length is at most one-fifth length of disc. l. Apex of gonocoxite of male variously modified, simple, bilobed or trilobed. m. Gonostylus of male elongate and narrow to greatly reduced to absent, never flattened and leaf-like. n. Penis valve apex is slender and long to wide and short; sometimes apically hooked. o. Penis valve bridge present, spatha absent (very weakly developed in a few rare cases). p. T7 of male either with two subapical teeth or pygidial plate; pygidial plate of female with margin simple or carinate. q. First recurrent vein of forewing joining submarginal cell 2 near midpoint, never meeting first r-m. r. Hind wing with cu-v subequal to second abscissa of M + Cu; cu-v slanted from M + Cu basad; vein M about three times length of second abscissa of M + Cu. s. Jugal lobe one-third or less length of vannal lobe. t. Wings essentially bare with well developed alar papillae.

Distribution. The tribe Anthophorini with about 600 species is one of the largest tribes in the family Anthophoridae, second perhaps only to the tribe Eucerini. Members of this tribe are found in the tropical and temperate zones of the world with particular abundance in xeric areas such as the southwestern United States, Mediterranean region, northern and eastern Africa and Australia.

Biology. These bees are swift flyers. Almost all of them nest in the ground, preferably in banks; a few nest in wood [subgenus *Clisodon* and perhaps *Anthophora (Anthophoroides) signata*]. Sometimes more than one species will nest at the same site (Schneider, 1982). I have seen *A. bomboides* and *abrupta* share the same nest site at Lawrence, Kansas [this was also noted at St. Louis, Missouri (Rau, 1926) and Baltimore County, Maryland (Norden and Scarbrough, 1982)] and *A. bomboides* and *californica* at Point Reyes National Seashore in California. Anthophorine bees commonly reuse the same nest site year after year, unlike many other bees. When the nesting substrate is displaced from the original location, bees may be attracted to it (Michener, 1960), suggesting that there is some chemical nesting marker that serves as a lure. Perhaps this is one reason why more than one species can be found occupying a single nest site.

Earthen (or saw dust in the case of *Clisodon*) cells are lined with wax and provisioned with a semi-liquid mass of pollen, nectar and Dufour's gland secretion (Norden et al., 1980). The wax lining and provisions give off a strong cheesy odor (Malyshev, 1925) from butyric acid, a product of the triglycerides of the Dufour's gland and probably salivary or gut enzymes (Norden et al., 1980) and is soluble in many solvents (Batra, 1972). The cell linings are thick and similar to those of habropodine bees. Compared to those of Habropodini, anthophorine cell linings are not thicker or do they differ in their separability from the cell wall; furthermore, there is no difference in burrow orientation, contrary to Marikovskaya (1976a).

The mandibular gland secretion may function as an alarm or aggregation pheromone in certain species of *Anthophora,* since netted females give off a mandibular gland secretion attracting other females by the hundreds (Thorp, 1969; Brooks, 1983; Batra, 1984). Some species have males which defend territories (Brooks, 1983) and females which vigorously defend their nests against parasitic bees (Batra, 1978).

Polylecty is generally the rule, as exemplified by *Anthophora plumipes* (cited under *A. acervorum*)

(Ruszkowski, 1966) and various species of Indian Anthophorini (Batra, 1967). Only two species are known to be narrowly oligolectic; they are *Anthophora phaceliae* n. sp. whose females visit almost exclusively various species of *Phacelia* (Hydrophyllaceae) (Brooks, unpublished) and *Amegilla (Glossamegilla) florea* which in Japan visits only *Impatiens textori* (Miyamoto, 1962).

The nesting behavior of *Amegilla* is as in species of *Anthophora*. Some species of the subgenus *Asaropoda* nesting in flat ground construct turrets over their nest entrances (Rayment, 1951; Michener, 1965). *Amegilla* flies generally in the summer, whereas species of *Anthophora* are generally active in the spring. Many species of *Amegilla* in the Mediterranean region are diminutive and superficially resemble species of *Anthophora* subgenus *Heliophila*.

Taxonomy. Numerous keys have been made to the adults of anthophorine genera; the most important covering North America are by Michener (1944), Mitchell (1962, only Eastern U.S.), Stephen et al. (1969); India (Batra, 1977), Europe (Friese, 1897; Schmiedeknecht, 1930), Egypt (Priesner, 1957), and European U.S.S.R. (Osychnyuk et al., 1978). Keys and descriptions

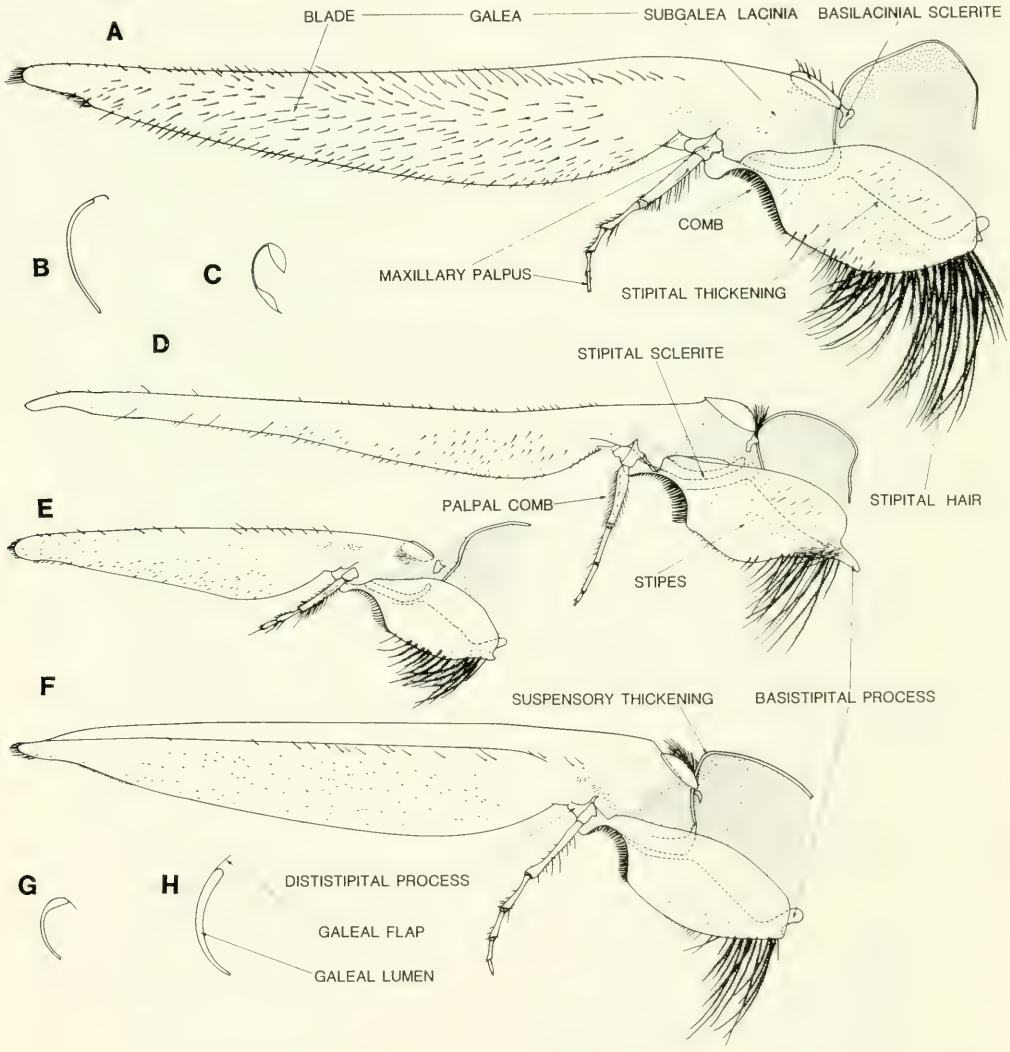


FIG. 5. Maxillae, outer views. A, B, *Anthophora (Anthophora) plumipes,* maxilla and cross section of galea at midlength. C, D, *Amegilla (Amegilla) quadrifasciata,* cross section of galea at midlength and maxilla. E, G, *Anthophora (Heliophila) bimaculata,* maxilla and cross section of galea at midlength. F, H, *Anthophora (Clisodon) terminalis,* maxilla and cross section of galea at midlength.

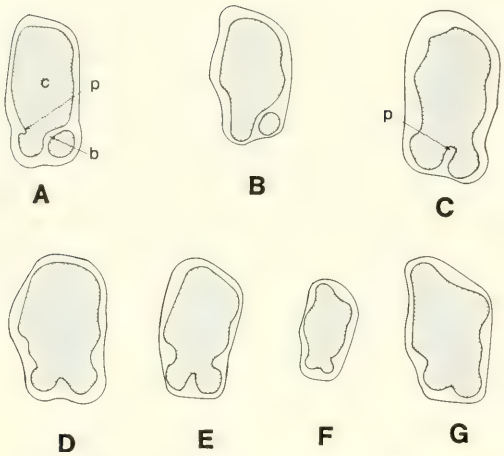


FIG. 6. Apices of female hind tibiae, apical views. Dotted areas indicate internal space. Acetabulum and tibial spurs omitted. Tibiae are oriented such that the outer and anterior surfaces are on the right and bottom, respectively. Tibial spurs would be attached in lower part of each drawing. b = exoskeletal bridge, c = internal space, p = exoskeletal process. A, *Amegilla (Amegilla) quadrifasciata*. B, *A. (Zonamegilla) comberi*. C, *A. (Glossamegilla) violacea*. D, *A. (Asaropoda) bombiformis*. E, *Anthophora (Anthophora) plumipes*. F, *A. (Heliophila) cockerelli*. G, *A. (Melea) occidentalis*.

of larval Anthophorini are given by Michener (1953), McGinley (1981) and Torchio and Stephen (1961).

Unplaced Species

The following species cannot be placed with certainty into the Anthophorini since the types are either lost or destroyed (all originally described in the genus *Anthophora* unless indicated otherwise): *Apis bihamata* Panzer, *citreostrigata* Dours, *Megilla excelsa* Gistel, *frontata* Say, *Apis incisa* Fourcroy, *luteodimidiata* Dours, *marsupoda* Christ, *mediozonata* Laboulbene, *melanopyrrha* Dours, *mexicana* Dours, *nigroaeruginosa* Dours, *ornata* Gistel, *pilosa* Lespes, *pluto* Dours, *pulsella* Dours, *pygmaea* Dours, *pyropyga* Dours, *pyrozonata* Dours, *repleta* Dours, *rufozonata* Dours, *Apis seminuda* Fabricius, *Megilla senilis* Illiger, *simia* Dours, *spodia* Dours, *tunicata* Gistel, *uniciliata* Sichel, *unistrigata* Dours and *volucellaeformis* Dours.

Anthophorini incertae sedis

The following species are either *Anthophora* or *Amegilla*. They cannot be placed with certainty in either genus since the types are lost or destroyed (in a few cases the types exist but have not been studied yet; all were originally described in *Anthophora* unless otherwise indicated): *alpatovi* Kuznetzov-Ugamsky, *angulosa* Hedicke, *annulifera* Walker, *cellularis* Cameron, *combusta* Dours, *dalmatiensis* Strand, *Megilla excelsior* Strand, *ferruginata* Lepeletier, *germabica* Radoszkowsky, *hastula* Vachal, *illepida* Walker, *imitatrix* Cockerell, *iranica* Hedicke, *jakobsoni* Kuznetzov-Ugamsky, *kuzini* Kuznetzov-Ugamsky, *laevigata* Spinola, *lepidodea* Dours, *leucomelaena* Dalla Torre, *leucosticta* Hedicke, *lutescens* Walker, *melaleuca* Lepeletier, *padiola* Vachal, *pallescens* Morawitz, *pauperata* Walker, *plagioleuca* Hedicke, *plebeja* Morawitz, *sauteri* Friese, *semenovi* Kuznetzov-Ugamsky, *semicinerea* Dours, *senex* Smith, *tekkensis* Gussakovsky, *variipes* Morawitz and *Megilla vetula* Klug.

Key to Genera of the Anthophorini

1. Arolia present, well developed (Fig. 9a); basistipital process with two projections (Figs. 5a, e, f); mentum simple or with anterior tooth on basal third (Fig. 22k); gonostylus almost always present and well developed; hair never metallic. . . . . *Anthophora*
— Arolia absent (Fig. 9c); basistipital process with one projection (Fig. 5d); mentum almost always with a single anterior tooth on basal third; gonostylus often greatly reduced to absent; hair sometimes metallic . . . . *Amegilla*

Genus *Anthophora* Latreille

Diagnosis. Arolia present (9a); hind leg of male often modified with teeth, midleg of male often

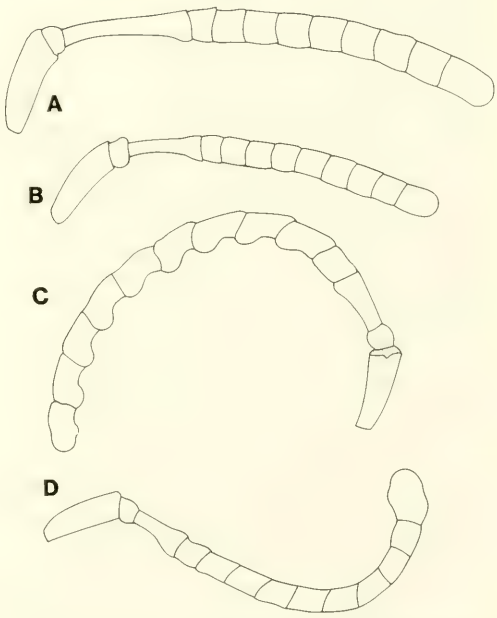


FIG. 7. Antennae of *Anthophora*. A, *A. (Lophanthophora) pacifica* female. B, *A. (Anthophoroides) californica* female. C, *A. (Paramegilla) astragali* male. D, *A. (Paramegilla) clavicornis* male.

with brushes; pubescence never blue or metallic, metasoma generally with shaggy hair, sometimes appressed; outer hind tibial spur not to only partially isolated from inner tibial spur [(Figs. 6e-g) see *Comments* under *Amegilla*]; anterior surface of mentum near basal third almost always without tooth; galea with a single, not "double," lumen (Figs. 5b, g, h).

Description. a. Body length 6.0-24.0 mm. b. Flagellar segment 1 of female equal to combined lengths of next 2.2-5.5 flagellomeres; of male to next 1.0-4.2 flagellomeres. c. Face of male with yellow to white integumental marking, rarely all black, of female all black, sometimes with pale integumental marking; clypeus protuberant at least .7 width of eye in profile (except *Mystacantho-phora*); labrum of male usually apically simple, occasionally trilobed (as in *Anthomegilla, Dasymegilla, Petalosternon,* weakly in *Clisodon* and some *Pyganthophora* and *Rhinomegilla*), labial palpus with four segments [except *A. (Paramegilla) fulvicauda* with three, *A. (Heliophila) hololeuca* with two]; mentum .5-.8 length of prementum, sometimes with an anterior tooth on basal third [as in *Melea, Anthophoroides,* and *A. (Dasymegilla) excisa*]; paraglossal length equal to .5-.9 length of stipes; galea with a single lumen (Figs. 5b, g, h). d. Midtarsal brush of male present [as in *Anthophora* s. str., *Lophanthophora,* and *Pyganthophora* (Figs. 2h, 12c)] or absent. e. Midbasitarsal brush of male present [as in *Anthophora* s. str., *Lophanthophora, Pyganthophora,* and *Caranthophora*) (Figs. 12c, 13j)] or

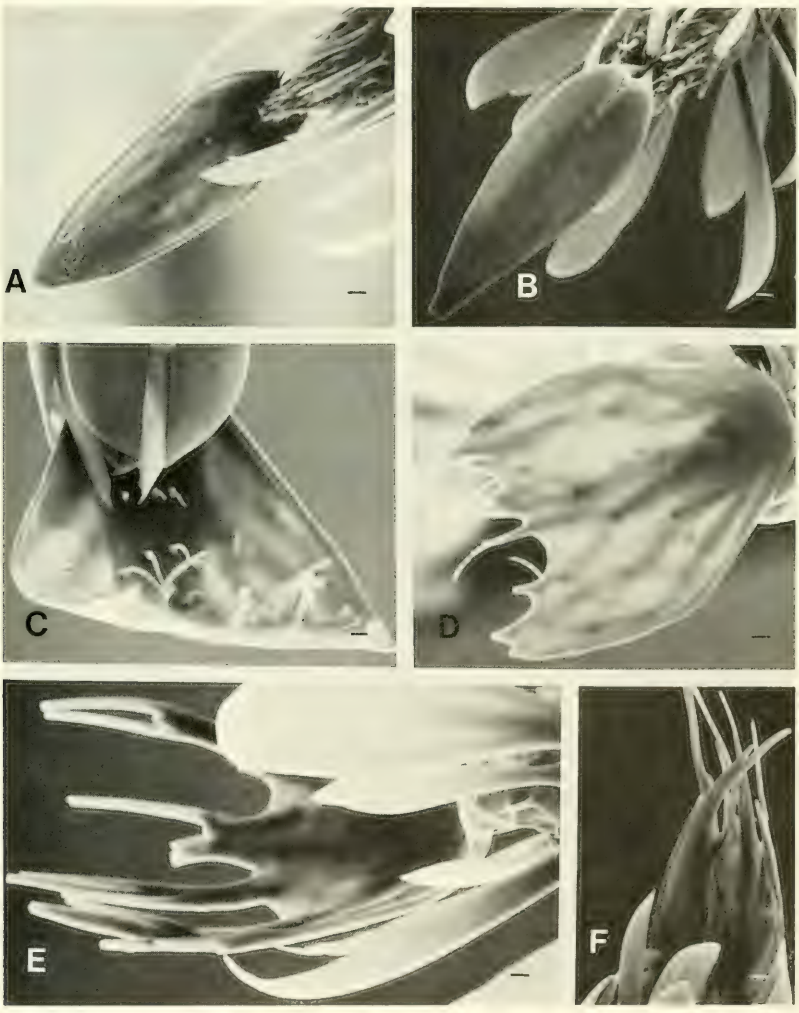


FIG. 8. Flabella. Scale lines represent .01 mm. A, B, *Anthophora (Anthophora) plumipes,* anterior and posterior views. C, D, *A. (Melea) abrupta* apicoanterior and posterior views. E, F, *Amegilla (Amegilla) quadrifasciata,* posterior and anterior views.

absent. f. Middistitarsal brush of male present [as in *Anthophora* s. str., *Lophanthophora, Pyganthophora,* and *Caranthophora* (Figs. 2h, 12c, 18k)] or absent. g. Hind basitarsus of male simple, almost parallel-sided or modified with an anterior weakly developed protuberance to a well developed tooth or longitudinal ridge, tarsus sometimes elongated (Fig. 20j); hind tibia of female with simple scopal hairs except posterior margin plumose (Figs. 10a, c) [posterior margin with simple hairs in *Anthomegilla, Clisodon, Melea, Rhinomegilla* and *Heliophila* (Fig. 10d, e)]. h. Apodeme of S7 of male short to long, 0.30-1.75 length of disc. i. Apex of gonocoxite of male with various modifications such as simple, bilobed or trilobed in profile, with or without lamellate carinae. j. Gonostylus of male short [as in *A. (Paramegilla) gracilipes*] to long (as in many *Lophanthophora*), 2-20 times longer than wide, flattened to round in cross section, possibly absent in a few species. k. Penis valve apex, as viewed apicodorsally, short to long and thick to thin, 0.9-4.5 times longer than wide (Fig. 2d). l. Penis valve bridge basally projecting (basal projection absent in *Anthomegilla*), basally entire to deeply emarginate, apically round (apically acute in *Rhinomegilla*), length 0.7-3.1 times as long as wide. m. Pygidial plate of male present [as in *Lophanthophora, Pyganthophora,* and most *Paramegilla* (Figs. 2g, 13c, 15c, 20h, i, k-n)] and sometimes with lateral tooth [some *Paramegilla* and *Lophanthophora* (Figs. 20h, i, k-m)] or when plate absent pygidium modified medioapically with two obtuse to acute teeth, with a median longitudinal ridge [*Anthomegilla, Rhinomegilla, Heliophila* and some *Paramegilla* (Figs. 19d, 25j, 26f)], actual apical margin flexed ventroanteriad [greatly so in *Dasymegilla* (Fig. 27f)]; gradular process of male T7 sometimes present [e.g., *Lophanthophora, Heliophila* and some *Pyganthophora* (Figs. 13c, g, 15c)]; pygidial plate of female with margin usually carinate, never with median longitudinal ridge but flat or gently convex, striate.

Distribution. *Anthophora* is found on all biogeographic areas except Australia, the Indomalaysian region and Madagascar. It is uncommon in Southeast Asia where only a few species of four subgenera are found. Three subgenera are subsaharan and only one is primarily neotropical.

Morphology. The morphology of adult and larval *Anthophora* was exhaustively illustrated and discussed by Michener (1944, 1953). Almeida Correia (1973) and Saunders (1891) illustrated the mouthparts of *Anthophora,* and more recently Michener and Brooks (1984) described its glossa.

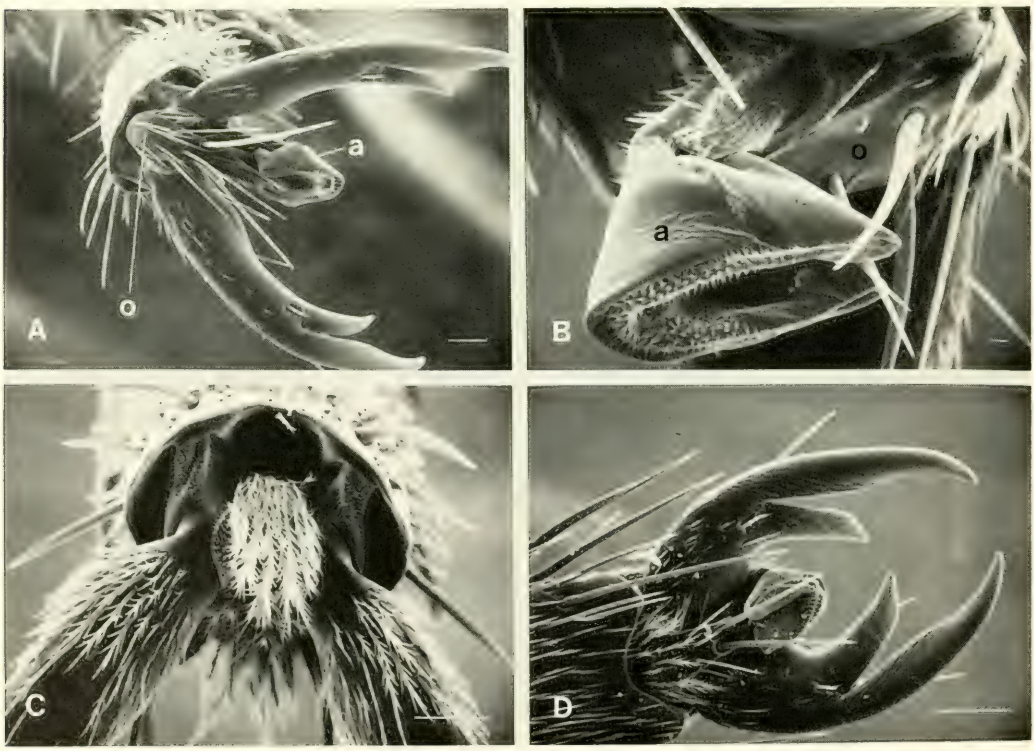


FIG. 9. Hind claws and arolia of females. Scale lines (on right side) represent .1 mm in A, C, D and .01 mm in B; o = orbicula, a = arolium. A, B, *Anthophora (Melea) abrupta,* dorsal and apical side views. C, *Amegilla (Amegilla) quadrifasciata,* dorsal view. D, *Anthophora (Mystacanthophora) arequipensis,* dorsal view.

The Dufour's gland was first illustrated by Trojan (1930). Brooks (1983) illustrated the terminalia of the New World species groups. Apomorphic characters for the genus are shown in the cladogram (Fig. 40).

KEY TO SUBGENERA OF *ANTHOPHORA*

1. Seven exposed metasomal terga; thirteen antennal segments; males 2
— Six exposed metasomal terga; twelve antennal segments; females 17
2. Midtarsus with middistitarsal brush (Fig. 2h), usually with midbasitarsal brush also (Fig. 12c); apex of S7 laterally with two lobes, a ventral and

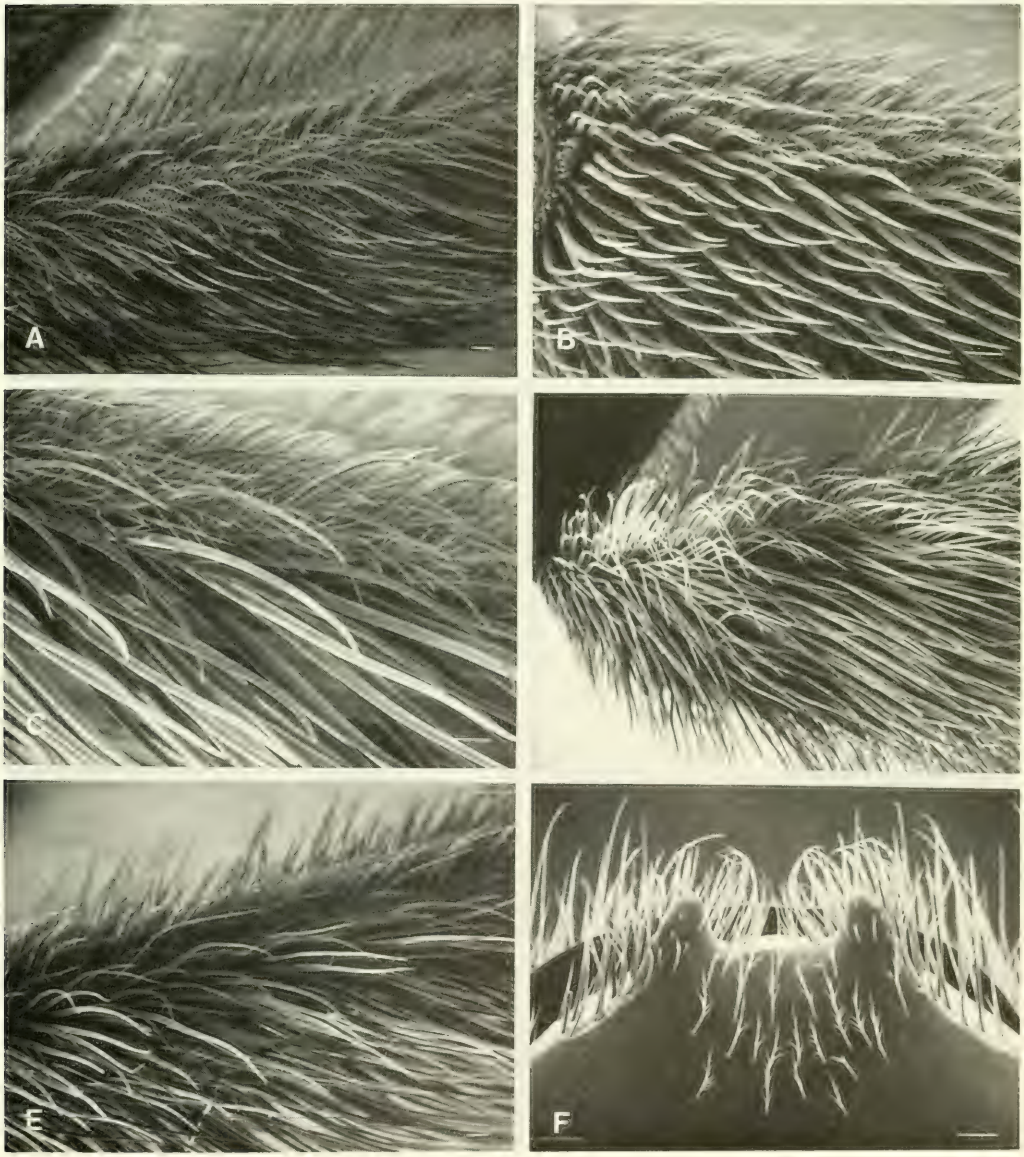


FIG. 10. A-E, Outer views of hind tibiae of females to show vestiture. A-C show band of plumose hairs along posterior margin of tibia, D and E lack such hairs. Scale lines (on lower right side) represent .1 mm. A, *Anthophora (Anthophora) plumipes*. B, *Amegilla (Amegilla) quadrifasciata*. C, *Anthophora (Mystacanthophora) capistrata*. D, *A. (Heliophila) bimaculata*. E, *A. (Melea) abrupta*. F, Ventral view of T7, *A. (Heliophila) bimaculata*.

dorsal one (Fig. 2a) 3
— Midtarsus simple, without any brushes; apex of S7 laterally simple (Figs. 16g, 19e, 20d, 22e) or with two lobes (Fig. 2a) 6
3. Basitibial plate absent; pygidial plate absent 4
— Basitibial plate present; pygidial plate present 5
4. Flabellum apically entire (Figs. 8a, b, 12j); S7 apically narrowed, elongate, apodemes at least 1.3 times as long as length of disc (Fig. 12n); apex of gonocoxite deeply bilobed (Figs. 12f-h) . . . . . *Anthophora*
— Flabellum apically with finger-like projections (Figs. 8d); S7 apically broad, short, apodemes no more than 0.4 times as long as length of disc (Fig. 18d); apex of gonocoxite weakly trilobed (Fig. 18a). . . . . *Caranthophora*
5. Distal half of S6 with a pair of apically diverging oblique ridges (Fig. 14d); apex of gonoxite simple, flattened, hooked ventrad (Figs. 14a, b) . . . . . *Lophanthophora*
— Distal half of S6 simple, without ridges (Fig. 13a); apex of gonocoxite bilobed or triangular, not flattened and hooked ventrad (Figs. 13b, d, l-n) . . . . . *Pyganthophora* (in part)
6. Mandible bidentate, sometimes simple; gonostylus lightly sclerotized, thus clearly demarcated from apex of gonocoxite; flabellum apically with finger-like lobes (Fig. 8c) 7
— Mandible tridentate; gonostylus concolorous with apex of gonocoxite, perhaps absent; flabellum apically simple (Figs. 29c, d) . . . . . *Clisodon*
7. Mentum with an anterior tooth near basal third (Fig. 22k); hind basitarsus with anterior tooth or strong ridge (Figs. 22i, 24i, j); apex of S7 with one lateral lobe (Figs. 22e, 24d) 8
— Mentum simple without anterior tooth near basal third (if a single tooth present then hind basitarsus simple, almost parallel-sided and without anterior tooth or ridge); hind basitarsus variable; apex of S7 with two lateral lobes, sometimes only weakly developed (Figs. 25e, 26d); if apex simple laterally or with one lobe, then body small (7.5- 13.5mm) and/or S6 with thick pad of hair (Figs. 30a, 32b) . . 9
8. Length at most 13 mm; hind tibia having apical spine with a tibial spur inserted near spine's apex (Figs. 24j); apex of gonocoxite heavily sclerotized (seen only in cleared preparation of genital capsule) with a distinct melanized demarcation between apex and base (Fig. 24f); face with white integumental markings (yellow in *A. vallorum* and *californica*) . . . . . *Anthophoroides*
— Length greater than 13 mm; hind tibia simple, without apical spine (Fig. 22i); apex of gonocoxite not more heavily sclerotized than base, no demarcation between the two (Fig. 22c); face with yellow integumental markings . *Melea*
9. Malar space long, more than one-third as long as wide (Figs. 25h, 26c); flabellum apically entire, elongate with apical two-thirds narrowed (Fig. 25d) or flabellum with numerous small apical lobes (Fig. 26b) 10
— Malar space almost always short and linear, at most one-third as long as wide (Fig. 1b); flabellum short and wide, apically with three to ten finger-like projections (Fig. 8e) or if entire, then apical two-thirds not narrowed and flabellum not with numerous, short apical lobes; S6 almost always medioapically emarginate (Figs. 30a, g) 11
10. Flabellum apically entire, elongate with apical two-thirds narrowed (Fig. 25d); pygidium of male with longitudinal median ridge not reaching apex, with two small submedian, weakly developed projections (Fig. 25j); penis valve bridge short, basally emarginate (Fig. 25f) . . . . . *Anthomegilla*
— Flabellum apically with numerous small lobed divisions, broom-shaped, and lateral margins almost parallel (Fig. 26b); pygidium apicomedially, dorsoventrally flattened, with longitudinal median ridge reaching apex (Fig. 26f); penis valve bridge long, basally pointed (Fig. 26h) . . . . . *Rhinomegilla*

11. Length usually 9-24mm; S6 simple without pad of hair; gradular process of T7 at most obtusely projecting, usually not developed (Figs. 13c, g, 27a); apex and base of disc of S7 wider than middle, apex laterally angulate or with two lobes as in Figures 13e, i, 16g, 20d, 27d, k 12
— Length usually 7.5-13.5mm and/or S6 with thick pad of hair (often hidden until sternum is relaxed and pulled apically); gradular process of T7 often prolonged into tooth (Figs. 30f, g) when body size is small; apodeme of S7 usually short, apex of disc laterally simple, not with two lobes, lateral margins of disc parallel or apically converging, or if narrowed medially then apex of disc laterally simple as in Figures 30e, 30j, 32e, 32i . . . . *Heliophila*
12. Pygidial plate present (Figs. 13c, g), sometimes lateral tooth below pygidial plate also present (Figs. 20h, i, k); gradular process of T7 sometimes present 13
— Pygidial plate and lateral tooth absent, apex of T7 with two submedian teeth (Figs. 27a, f); gradular process of T7 absent 14
13. Basitibial plate present (Fig. 29a) and hind basitarsus simple, nearly parallel-sided; pygidial plate with margin carinate and not concave (Fig. 13c); gradular process of T7 sometimes present (Fig. 13c). . . . *Pyganthophora* (in part)
— Basitibial plate absent or if present, then hind basitarsus with anterior process dilated, not parallel-sided; pygidial plate with margin rounded, almost never carinate (Figs. 20h, i, k-m) if carinate, then lateral margin concave (Fig. 20n); gradular process of T7 absent . . . . . *Paramegilla* (in part)
14. S7 apically broad as in Figures 16g, 27d; S8 with broad, deep apical emargination (weak in *A. calcarata*), lateral margin on apical half concave (Figs. 16h, 27b) 15
— S7 apically narrow as in Figures 19e, 27k; S8 with narrow shallow apical emargination, lateral margin on apical half angulate or concave (Figs. 19c, 27h) 16
15. S8 with apicolateral margin angulate, spiculum projecting somewhat basally (Fig. 27b); S7 with apex shallowly emarginate with two weakly developed apicolateral lobes, apodeme with lateral process (Fig. 27d); apex of gonocoxite somewhat bilobed in profile, lower lobe weakly developed, not with carinae, sometimes with a tooth on lower inner margin of gonocoxite (Fig. 27e); face almost always with yellow markings . . . . . *Petalosternon*
— S8 with apicolateral margin prolonged and rounded, spiculum not easily visible from ventral aspect but projecting dorsally at a 90 degree angle (Fig. 16h); S7 with apex distinctly emarginate with two strong apicolateral lobes, apodeme without lateral process (Fig. 16g); apex of gonocoxite complex in profile with dorsoventral and lateral carinae (Fig. 16k); face with white markings . . . . . *Mystacanthophora*
16. T7 with two short submedian teeth, their bases separated by convex lamellate (Fig. 19d) or angular apical margin; median longitudinal carina often present; actual apical zone of T7 as seen from ventral view, narrow where bent anteroventrad as in Figure 27a; hind basitarsus anteriorly with tooth, blunt process or longitudinal ridge (Figs. 19g, 20g, j, o); apodemes of S7 almost always short (see character j of *Paramegilla*), .34-.78 as long as length of disc, lateral process absent (Figs. 19e, 20d); apex of gonocoxite in profile simple to weakly bilobed (Figs. 19b, 20b). . . . . *Paramegilla* (in part)
— T7 with two long submedian teeth, their bases separated by rounded apical margin; actual apical zone of T7 as seen from ventral view wide where bent ventroanteriad (Fig. 27f); hind basitarsus almost paralled-sided, anteriorly simple; apodemes of S7 long, 1.00-1.75 as long as length of disc, lateral process present (Fig. 27k); apex of gonocoxite in profile deeply bilobed (Figs. 27j). . . . . *Dasymegilla*
17. Flabellum narrowly elongate, apically

entire (Figs. 8a, 25d) or with numerous short, small lobes (Fig. 26b); flagellomere 1 equal in length to next 3.2-4.0 flagellomeres taken together 18

— Flabellum wide, with few long finger-like apical lobes (Fig. 8c); flagellomere 1 equal in length to next 2.2-5.5 flagellomeres taken together 20

18. Malar space long, more than one-third as long as wide (Figs. 25h, 26c); flabellum elongate with apical two-thirds narrowed (Fig. 25d) or flabellum with numerous small apical lobes (Fig. 26b); posterior longitudinal margin of hind tibia with scopal hairs simple as in Figure 10e 19

— Malar space almost always short, rarely well developed, at most one-third as long as wide (Fig. 12e); flabellum more or less parallel sided, not narrowed in apical two-thirds, apex entire (Fig. 12j); posterior longitudinal margin of hind tibia with scopal hairs plumose (Fig. 12d) . . *Anthophora* s. str.

19. Flabellum apically entire, elongate with apical two-thirds narrowed (Fig. 25d) . . . . . *Anthomegilla*

— Flabellum apically with numerous small lobes (Fig. 26b). . . *Rhinomegilla*

20. Mentum near basal third with a well developed anterior tooth (Fig. 22k); flagellomere 1 equal in length to next 2.4-3.3 flagellomeres taken together 21

— Mentum on basal third simple, without anterior tooth [if with tooth then from the Old World and with posterior longitudinal zone of scopa plumose *(A. excisa)*]; flagellomere 1 equal in length

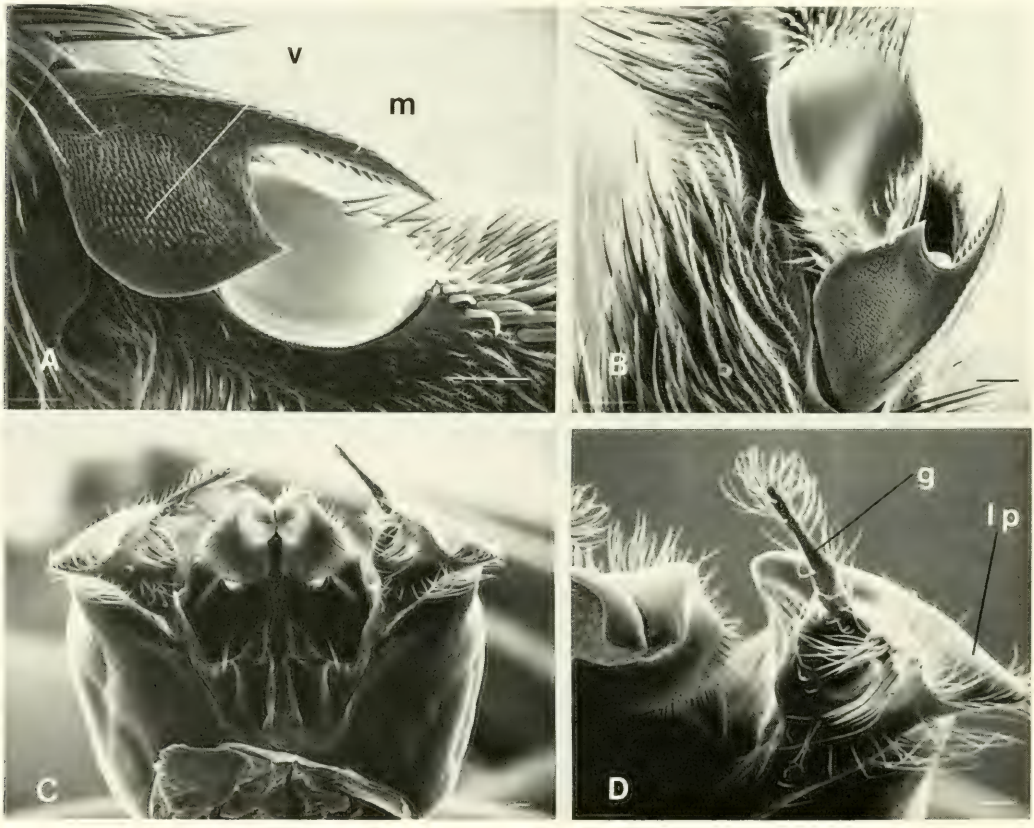


FIG. 11. Antennal cleaner and genital capsule. Scale lines (on right side) represent .1 mm; v = velum, m = malus, g = gonostylus, lp = lateral carinal process. A, B, strigilis of female of *Anthophora (Mystacanthophora) arequipensis* and *Amegilla (Amegilla) quadrifasciata.* C, D, *Anthophora (Mystacanthophora) urbana,* ventral view of genital capsule and apex of gonocoxite.

to next 2.2-5.5 flagellomeres taken together 22

21. Hind basitarsus with posterior distal process acute (Figs. 22h, 23c); S6 with subapical tooth; posterior margin of hind tibia with simple hair (Figs. 10e, 22h); body longer than 13 mm . . . . . *Melea*

— Hind basitarsus with posterior distal process blunt as in Figure 12d; S6 without subapical tooth; posterior margin of hind tibia with plumose hair (Fig. 10a); body no longer than 13 mm . . . . . *Anthophoroides*

22. Posterior margin of hind tibia with simple hair (Figs. 10d, e, 22h); length 6-15 mm. 23

— Posterior margin of hind tibia with plumose hair (Figs. 10a, c, 12d); length 10-24 mm 24

23. Face black, body length 12-14 mm; Mediterranean region . . . . . *Paramegilla* (in part)

— Face almost always with yellow to white integumental markings and body length 6-15 mm; if face black then length from 11-13 mm and southern African in distribution . . . . . *Heliophila*

24. Clypeus almost always black, rarely with pale integumental marking, if markings are present then not in shape of inverted "T" or if in shape of inverted "T", then flagellomere 1 longer than combined lengths of next three flagellomeres 25

— Clypeus with pale integumental marking in shape of inverted "T" (Fig. 18g); flagellomere 1 equal in length to next 2.2-3.0 flagellomeres taken together . . . . . *Caranthophora* (in part)

25. Metasoma with apical bands of hair complete and/or surface covered with semi-erect to erect hair. 26

— Metasoma with apical bands of hair interrupted medially or surface covered evenly with appressed hair (Figs. 21c-e). . . . . *Paramegilla* (in part)

26. Clypeus normal, without apically hooked or wavy hairs or basal pecten; flagellomere 1 equal in length to next 2.2-5.5 flagellomeres taken together . . . . . *Caranthophora* (in part), *Dasymegilla, Lophanthophora, Mystacanthophora* in part), *Paramegilla* (in part), *Petalosternon* and *Pyganthophora*

— Clypeus flattened, with hairs apically hooked or wavy, with a basal pecten (Figs. 17a-e); flagellomere 1 equal in length to next 2.2-3.4 flagellomeres taken together. . . . . *Mystacanthophora* (in part)

Subgenus *Anthophora* Latreille s. str.

Podalirius Latreille, 1802a, p. 430. Name suppressed by ICZN Opinion 151 (Hemming, 1944).

Anthophora Latreille, 1803, p. 167.

Type species: *Apis pilipes* Fabricius, 1775 (=*Apis plumipes* Pallas, 1772, see *Comments*) designated type and *Anthophora* put on Official List of Generic Names by ICZN, Opinion 151 (Hemming, 1944).

Lasius Panzer, 1804, H. 86, T. 16. **New Synonym.**

Type species: *Lasius salviae* Panzer, 1804 (=*Anthophora crinipes* Smith, 1854, p. 324). Monobasic. (See *Nomenclatorial History*).

Megilla Fabricius, [1805], p. 328. See Richards (1935) for comment on the date.

Type species: *Apis pilipes* Fabricius, 1775, designated by Michener, 1984, p. 139.

Diagnosis. Male without pygidial plate, with two submedian teeth on apex of T7 (Fig. 12k); midtarsal, midbasitarsal, middistitarsal brushes of male almost always present (Fig. 12c); S7 on lateral margin of disc with two well developed lobes, a dorsal and a ventral one, apodeme long, never with lateral tooth (Fig. 12n); S8 wide apically, spiculum from ventral aspect short and blunt (Fig. 12i); apex of gonocoxite deeply bilobed (Figs. 12f, g); flabellum apically entire, not lobed (Fig. 12j); basitibial plate of male weakly delimited to absent.

Description. a. Flagellar segment 1 of female equal to length of next 3.25-4.00 segments together; of male to next 2.00-3.75 segments. b. Face of male with yellow markings, of female black (except labrum of *A. melanognatha* has light-yellow spot); mandible of male with pale spot. c. Malar space of female about five times wider than long, of male about six times wider than long; flabellum apically simple, without deeply lobed anterior margin (Fig. 12j); mentum simple without anterior tooth basally, mentum about .6-.7 as long as prementum; paraglossa about .6-.8 as long as stipes. d. Midtarsal brush of male well developed (Fig. 12c) (except absent in *lanata,* weakly developed in *fulvitarsis* and *subterranea*). e. Midbasitarsal brush of male well developed (Fig. 12c) (except absent in *lanata*). f. Middistitarsal brush of male well developed (Fig. 12c) (except weakly developed in *lanata*). g. Hind basitarsus of male simple (Figs. 12a, b). h. Basitibial plate of male poorly defined to absent. i. S6 of male apicomedially emarginate [emargination slight to

absent in *plumipes* (Fig. 12l)], with a lateral depression (Fig. 12l), with a submedian lightly sclerotized area. j. Disc of S7 of male narrowly emarginate apically, with apicolateral angle, lateral margin medially with ventral lobe, basally with dorsal lobe, in profile as in Figure 12m; base of disc with a pair of protuberances, sometimes only represented by darkly sclerotized areas (Fig. 12n); apodeme long, at least 1.33 times as long as disc. k. S8 of male with four small projections apically, submedian pair more darkly sclerotized than lateral pair; longitudinal sclerotization absent (Fig. 12i). l. Apex of gonocoxite of male deeply bifid, inner arm bearing gonostylus (Fig. 12f). m. Gonostylus of male from ventral view long, about 5.75 times longer than wide (Fig. 12f). n. Penis valve apex large, about twice as long as wide viewed apicodorsally. o. Penis valve bridge basally emarginate (sometimes only weakly), of moderate length, 1.5-2.0 times longer than wide. p. Pygidial plate of male absent; T7 with two apical submedian teeth separated by emargination two or more times as wide as deep; gradular process of T7 absent. q. First recurrent vein joining submarginal cell 2 distad of midpoint (occasionally meeting submarginal cell at midpoint). r. Sting in repose slightly exceeding apex of gonostylus, twice as long as gonostylus. s. Body length 10-19 mm.

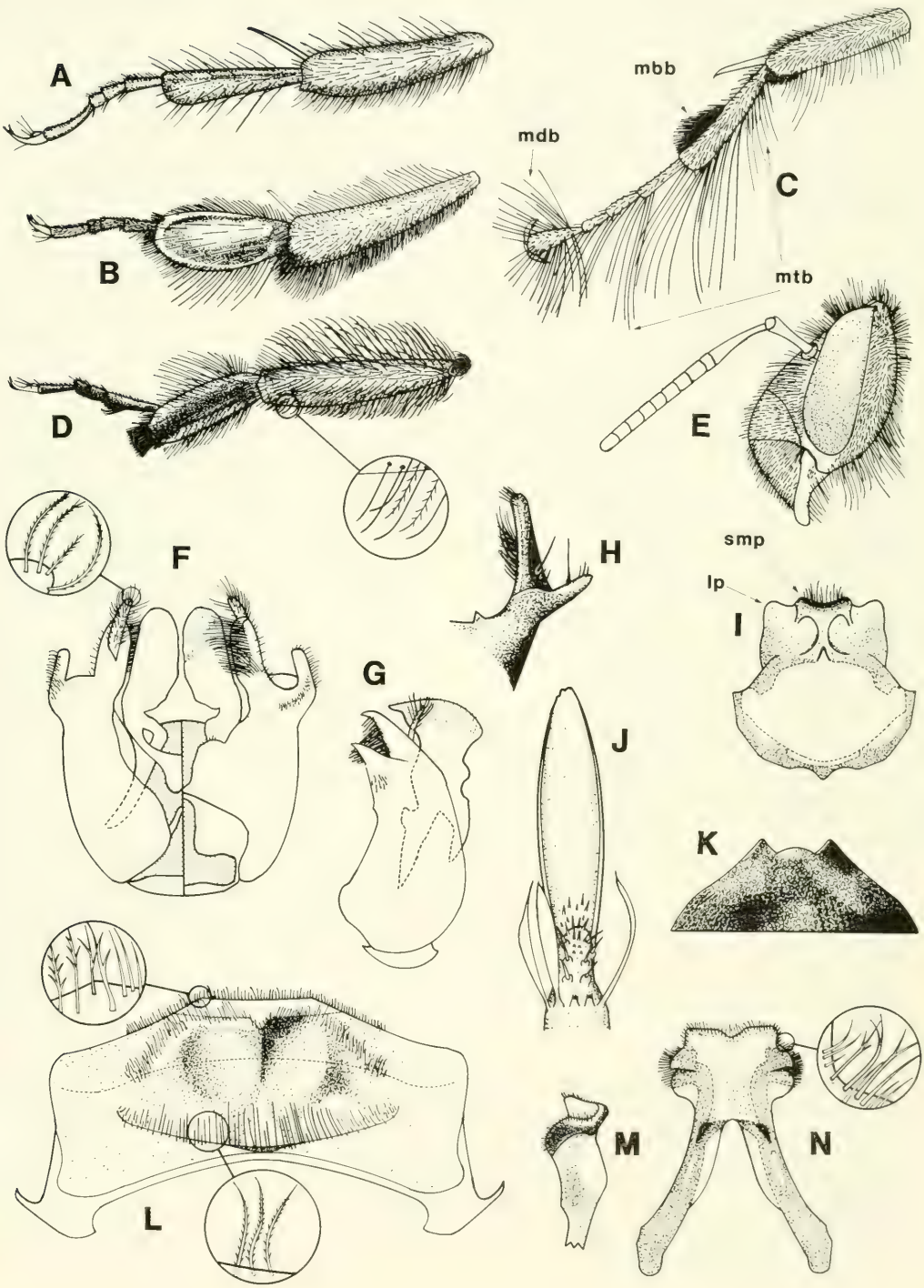
Comments. This subgenus is closely related to *Pyganthophora* from which it can be separated readily in the male by the absence of a pygidial plate, the presence of two well developed lobes on the lateral margin of S7 apically and of a long acute spiculum as seen in ventral aspect; in the female by the shape of the flabellum which is apically entire.

Nomenclatorial History. Day (1979) discussed at length the status of *Apis acervorum* Linnaeus, 1758, long regarded as the type species of *Anthophora.* In reviewing the work of Kirby (1802), Løken (1973) and others noted that he placed *A. acervorum* L. as a species of *Bombus* but was uncertain as to which one. (The type is believed lost.) Dahlbom (1832), Thomson (1872) and Løken (1973) placed *A. acervorum* L. as a synonym of *Apis subterranea* L., which is a species of *Bombus.* Linnaeus (1746, 1758) indicated that *Apis acervorum* was similar to *A. subterranea* L. and *A. terrestris* L. and later (1761) to *A. lucorum* L., all species of *Bombus.* Kirby (1802) suspected that *A. acervorum* L. was a male of *A. harrisella* Kirby, which is a melanic *Bombus hortorum* (Løken, 1973 and pers. comm.). In the Scandinavian populations of *Bombus subterraneus* queens and workers may have a somewhat yellow collar and slightly melanic males may occur (Løken, 1973 and pers. comm.) and would fit the Linnaean description of *A. acervorum* reasonably well. Fabricius (1775) was the first to mistakenly apply the name *acervorum* L. to a species now placed in *Anthophora.* As Kirby (1802) pointed out and Illiger (1806) reiterated, Fabricius used the name *acervorum* for *Apis plumipes.* He subsequently added to the Linnaean description "tibiis posterioribus ferrugineis," which Gmelin (1790) later incorporated in the 13th edition of Systema Naturae. Considering the arguments of Day (1979), Løken's familiarity with the color variation of Scandinavian *Bombus* spp., and the Linnaean diagnosis of *Apis acervorum,* it seems reasonable to agree that *A. acervorum* is a synonym of a species of *Bombus* and probably *subterraneus.* The next available name for *A. acervorum* of Fabricius and most subsequent authors is *Apis plumipes* Pallas, 1772 (=*Apis pilipes* Fabricius, 1775).

The first designation of the type species of *Megilla* Fabricius [1805] was *M. labiata* Fabricius [1805], by Westwood (1840). Since *M. labiata* F. is also the type species of *Macropis* Klug, 1809, a well known genus of melittids, Michener (1983) proposed the suppression of the Westwood type designation, as did Benson, Ferrière & Richards (1937). This proposal would in effect validate the second type species designation for *Megilla* by Richards (1935) i.e., *A. acervorum* L. But Richards unwittingly misidentified *A. acervorum* L., following most authors since Fabricius, having the Fabrician *acervorum* (=*A. plumipes*) in mind, not knowing the probable identity of *Apis acervorum* Linneaus. Since *A. acervorum* of Linneaus is a synonym of *B. subterraneus,* which is the type of *Subterraneobombus* Vogt, 1911, *Megilla* would have priority over that subgenus of *Bombus.* The least disruptive measure would be to designate *Apis pilipes* Fabricius, 1775, to replace *A. acervorum* L. as type of *Megilla,* following Michener (1984); thereby, *Megilla* would become a junior synonym of *Anthophora.* Following this course, the ICZN designated *Apis pilipes* Fabricius, 1775, as the type species of *Megilla* Fabricius [1805] (Tubbs, 1986).

Lasius Panzer 1804, not to be confused with *Lasius* Jurine [1801-1802] ("Erlangen List", suppressed by ICZN, Opinion 135) or *Lasius* Fabricius [1805] (a genus of ants), has as its type species *Lasius salviae* Panzer, 1804, by monotypy. Since *Lasius* Fabricius was placed on the Official List of Generic Names, *Lasius* Panzer is a homonym of the former and a synonym under *Anthophora.* When *Lasius salviae* Panzer is reassigned to

FIG. 12. *Anthophora* subgenus *Anthophora.* A, H, *A. (A.) melanognatha,* male; B-G, I-N, *A. (A.) plumipes;* lp = lateral process of apex of S8, mbb = midbasitarsal brush, mdb = middistitarsal brush, mtb = midtarsal brush, smp = submedian process of apex of S8. A, Hind leg (outer view). B, C, Hind and midleg of male (outer view). D, E, Hind leg, outer view and head, side view of female. F, G, Genital capsule, dorsoventral and side views. J, Flabellum, anterior view. K, Apex of T7 of male (hair omitted), dorsal view. L, S6 of male, ventral view. M, N, S7, disc, side view and S7, ventral view.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the genus *Anthophora* there is no problem of homonymy with *Anthophora salviae* Morawitz, 1876, since the latter is a species of the genus *Amegilla*. Article 59c of the ICZN states that as long as the two taxa in question are not congeneric, the junior homonym does not require a new replacement name.

Plumipes Species Group

g. Hind basitarsus of male flattened and wide (Fig. 12b) (*A. salviae* narrow), not angulate anteriorly. h. Basitibial plate of male absent. i. S6 of male without protuberances (Fig. 12l). j. S7 of male with apodeme about twice as long as length of disc (Fig. 12n). l. Arms of male gonocoxite curved and irregularly shaped (Fig. 12f). m. Gonostylus of male moderate in width, 5.7-6.0 times longer than wide (Fig. 12f). o. Penis valve bridge about twice as long as wide. p. T7 of male with submedian apical teeth about .1 as long as distance between their outer bases (Fig. 12k).

Biology. Almost all of the known biology of *Anthophora* s. str. is based on studies of *A. plumipes* (as *acervorum*) by Malyshev (1928), Nielsen (1902), Torikata (1931, as *villosula*), Van Lith (1947), and Verhoeff (1892a, b). Radović and Krunić (1977) reported on the biology of *salviae* (as *A. crinipes*). Polychromatism is found in *Anthophora* s. str. as well as in other subgenera.

Included Species. A. (Anthophora) chinensis Friese, *lanata* (Klug), *patruelis* Cockerell, *plumipes* (Pallas), *salviae* (Panzer), *senescens* Lepeletier, and *uljanini* Fedtschenko. They occur from Europe to Korea and eastern China.

Melanognatha Species Group

g. Hind basitarsus of male longitudinally angulate and narrow (Fig. 12a). h. Basitibial plate of male present but poorly defined (absent in *A. fulvitarsis*). i. S6 of male with two lateral protuberances and a subapical median protuberance. j. S7 with apodeme about 1.33 times as long as length of disc. l. Arms of male gonocoxite straight and gradually tapering apically (Fig. 12h). m. Gonostylus of male narrow, about 9 times as long as wide. o. Penis valve bridge about 1.5 times as long as wide. p. T7 of male with apical teeth about .4 as long as distance between their outer bases.

Biology. The biology of *A. aegyptiaca* (Ibrahim, 1976; Mohamed, 1975) and *fulvitarsis* (sometimes reported as *personata*) (Escalera, 1910; Nielsen, 1902; Semichon, 1906; Verhoeff, 1892a) has been studied.

Included Species. A. (Anthophora) aegyptiaca Dalla Torre & Friese, *fulvitarsis* Brullé, *melanognatha* Cockerell, and *subterranea* Germar. All are largely Mediterranean species.

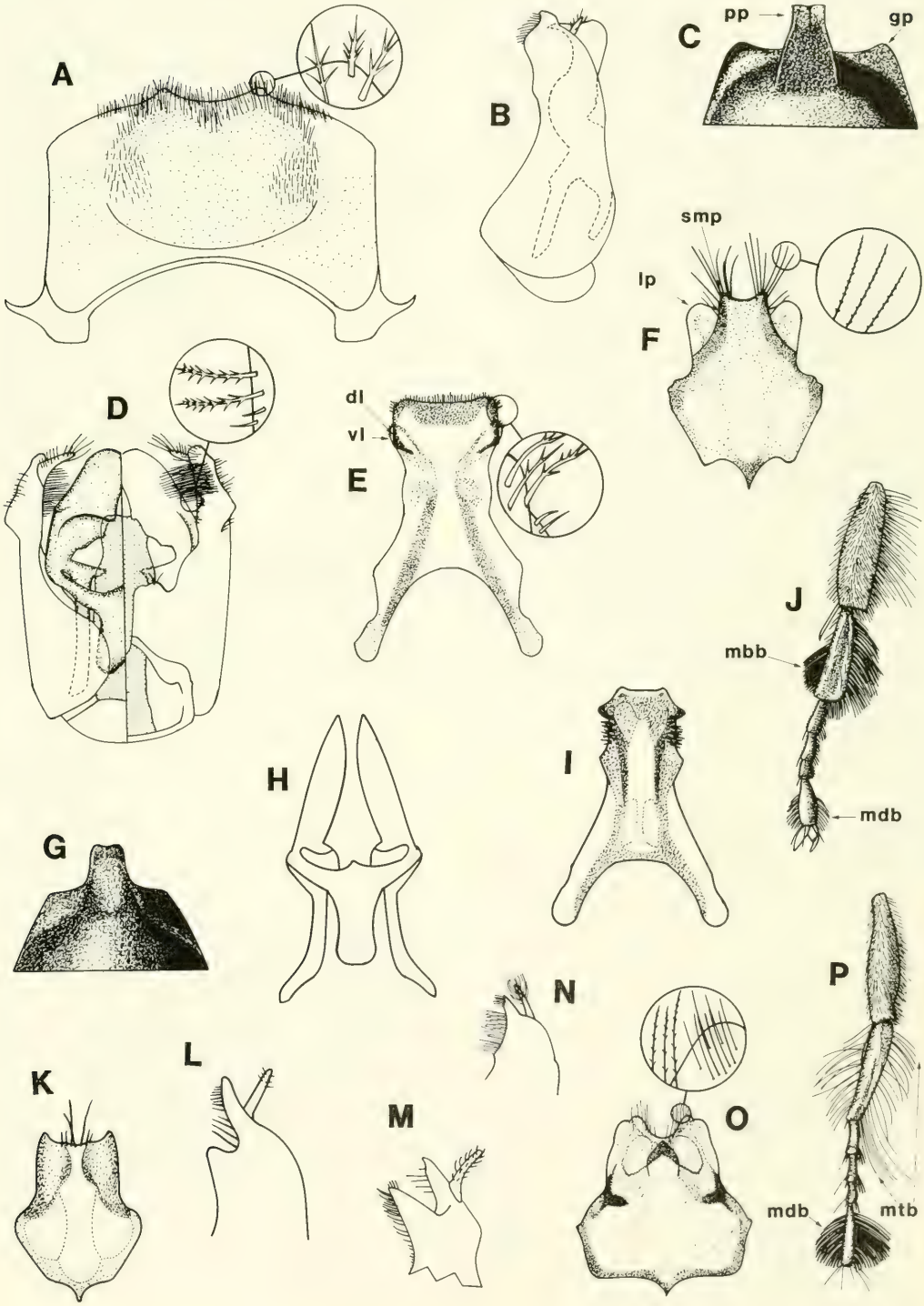
***Pyganthophora* new subgenus**

Type Species: *Apis retusa* Linnaeus, 1758.

Diagnosis: Male with a well developed pygidial plate (Figs. 13c, g); midtarsal, midbasitarsal, and middistitarsal brushes of male present or absent; S7 of male with two weakly developed lobes, a dorsal and a ventral one, both on lateral margin of apical half, apodeme often with a lateral tooth (Figs. 2a, 13e, 13i); S8 of male apically wide, spiculum in ventral aspect long and acute (Figs. 2b, 13f, 13k), apex of gonocoxite of male weakly to strongly bifid, rarely simple.

Description: a. Flagellar segment 1 of female equal to length of the next 3.75-5.50 segments together; of male to next 2.67-4.20 segments. b. Face of male with yellow (except all black in *A. angolensis, belieri, erschowi, nigriceps, nigrifacies, rogenhoferi,* and *sichelii;* with white in *albosignata, leucorhina, scopipes,* and *spinolana*); face of female black; mandible of male black (except *crotchii, forbesi,* and *platti* with yellow spot basally, *altaica* and *leucorhina* with white). c. Malar space of female 3.0-6.0 times as wide as long, of male 3.3-9.0 times as wide as long; flabellum with several long finger-like lobes at apex; mentum simple, without anterior tooth basally, mentum .6-.7 as long as prementum; paraglossa .6-.9 as long as stipes. d. Midtarsal brush of male absent [except in the western U.S. *crotchii, lesquerellae,* and *vannigera* (Fig. 13p)]. e. Midbasitarsal brush of male absent to present [well developed in *alluaudi, angolensis, atroalba, balearica, belieri, erschowi, holoxantha, retusa,* and *sichelii* (Fig. 13j)]. f. Middistitarsal brush of male absent to well developed (Figs. 13j, p). g. Hind basitarsus of male simple, without tooth (except in *edwardsii*), flattened, 2.8-4.1 times as long as wide. h. Basitibial plate of male well defined (Fig. 29a). i. S6 of male apicomedially emarginate, lateral depression and a central lightly sclerotized area sometimes present on disc (Fig. 13a). j. Disc of S7 of male (Figs. 13e, i) broadly and shallowly emargi-

FIG. 13. *Anthophora* subgenus *Pyganthophora,* males. dl = dorsal lobe of apicolateral margin of S7, gp = gradular process of T7, lp = lateral process of S8, mbb = midbasitarsal brush, mdb = middistitarsal brush, mtb = midtarsal brush, pp = pygidial plate, smp = submedian process of S8, vl = ventral lobe of apicolateral margin of S7. Hair is omitted from the apex of T7 (C, G). A-F, J, *A. (P.) retusa;* G, N-P, *A. (P.) crotchii;* H, I, K, L, *A. (P.) rogenhoferi;* M, *A. (P.) edwardsii.* A, S6, ventral view. B, Genital capsule, side view. C, Apex of T7, dorsal view. D, Genital capsule, dorsoventral view. E, F, S7 and S8, ventral views. G, Apex of T7, dorsal view. H, Penis valves, dorsal view. I, S7, ventral view. J, Midleg, outer view. K, S8, ventral view. L-N, Apex of gonocoxite, side view. O, S8, ventral view. P, Midleg, outer view.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nate apically, with apicolateral angle, lateral margin apically with a dorsal and ventral lobe as in Figure 13e; base of disc with dark sclerotized areas sometimes present (Fig. 13i); apodeme short to long, 0.5-1.0 times as long as length of disc. k. S8 of male (Figs. 13f, k, o) with 2 or 4 apical projections; longitudinal sclerotization present. l. Apex of gonocoxite of male weakly to strongly bifid (Figs. 13l-n). m. Gonostylus of male short to moderate in length, 5.0-8.5 times as long as wide (Figs. 13l-n) (13.5 times as long as wide in *platti*), narrow and sometimes flattened. n. Penis valve apex small and narrow to large and thick, 1.0-4.5 times longer than wide viewed apicodorsally. o. Penis valve bridge basally emarginate (Fig. 13d) [except in Rogenhoferi species group (Fig. 13h)], 1.3-3.0 times longer than wide. p. Pygidial plate of male present, well defined, apically entire to weakly emarginate (strongly emarginate in *orientalis*) without teeth (Figs. 13c, g); lateral margins carinate, rarely only angulate; gradular process of T7 of male absent to present. q. First recurrent vein joining submarginal cell 2 distad of midpoint. r. Sting in repose attaining or surpassing apex of gonostylus, 2.0-2.5 times as long as gonostylus. s. Body length 12-16 mm.

Comments and Biology. Pyganthophora flies from February to June. The Nearctic species are referred to as the Edwardsii group by Brooks (1983), but are here placed in two groups, one of which is Holarctic and Ethiopian. *Pyganthophora* is closely related to *Anthophora* s. str. but can be separated from it by the apically lobed flabellum, the presence of a pygidial plate in the male and the characters of the male S7, S8 and genital capsule given in the diagnosis.

Etymology. Pygos (Gr.), rump, a prefix referring to the well defined pygidial plate of the males, plus *Anthophora.*

Retusa Species Group

d. Midtarsal brush of male absent (Fig. 13j). e. Midbasitarsal brush of male present (except *A. altaica, arabica, edwardsii, forbesi, subterranea, senilis,* and *testaceipes*). f. Middistitarsal brush of male weakly to moderately developed (Fig. 13j), (absent in *arabica, edwardsii, erschowi, senilis,* and *testaceipes*). j. Disc of S7 of male basally without dark sclerotized areas (except the western U.S. species, *edwardsii* and *forbesi*); apodeme 0.7-1.0 times as long as length of disc (Fig. 13e). k. Apex of S8 of male (Fig. 13f) narrowly emarginate with four apical projections, submedian pair more darkly sclerotized and more acute than lateral pair (seen only in cleared preparation). l. Apex of gonocoxite of male strongly bifid (Figs. 13l, m) [weakly bifid in *alluaudi, angolensis, belieri, erschowi, holoxantha, retusa,* and *testaceipes* (Figs. 13b, n)]. n. Penis valve apex large and thick, 1.0-2.0 times longer than wide viewed apicodorsally. o. Penis valve bridge short and narrow (wide in *platti*), 1.3-2.0 times long as wide, basally emarginate. p. Gradular process of T7 of male present, well defined (absent in Nearctic species).

Biology. The biology of two Old World species has been studied - *retusa* (sometimes under the names *aestivalis* or *monacha*) (Nielsen, 1902; Popova, 1984) and *atroalba* (as *antiope,* Batra, 1980). Only a single New World species of *Pyganthophora, edwardsii,* has been investigated biologically (Thorp, 1969).

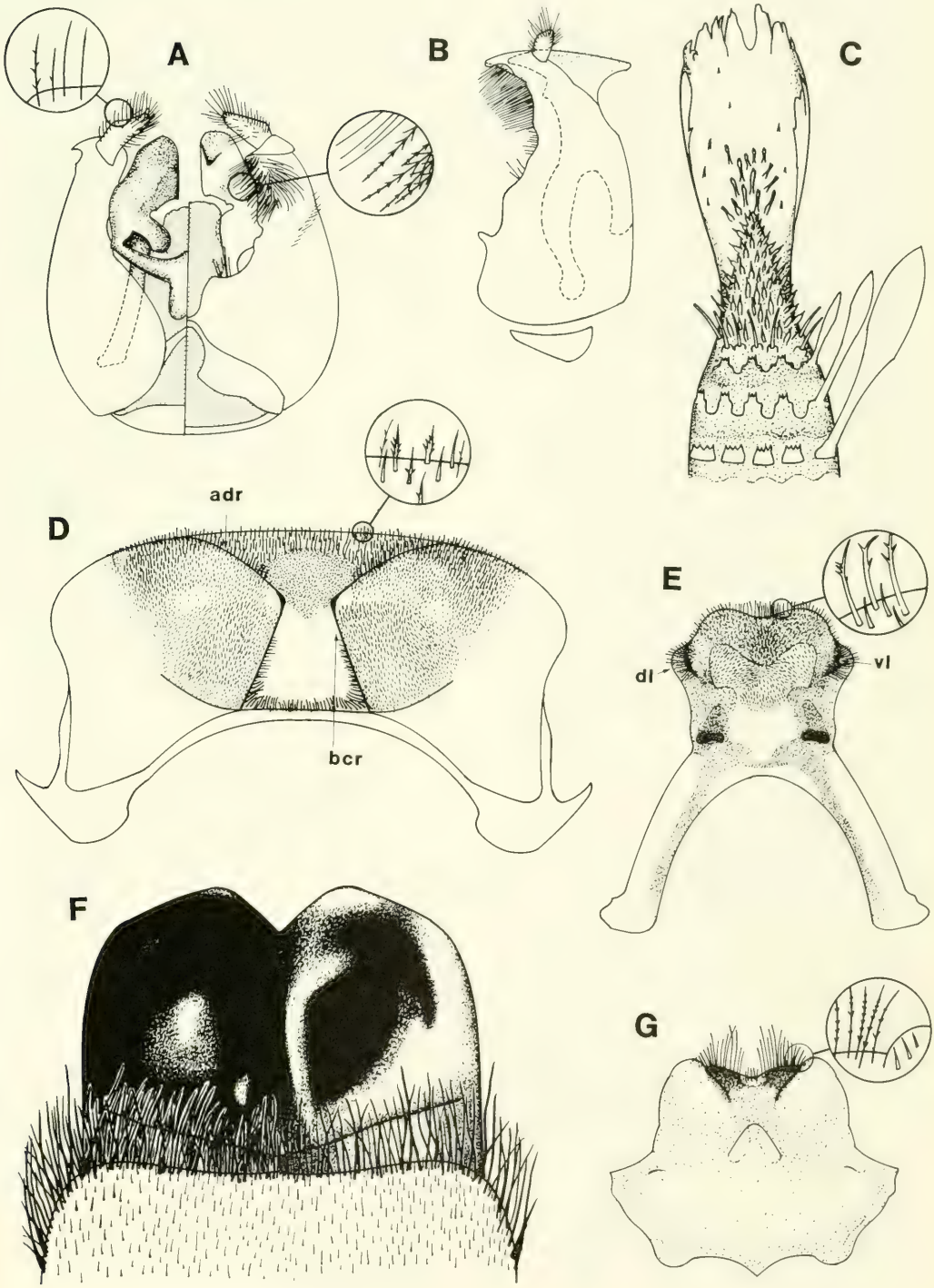
Included Species. A. (Pyganthophora) adamsorum n. sp., *albobarbata* Hedicke, *alluaudi* Pérez, *altaica* Radoszkowsky, *angolensis* (Dalla Torre) new combination, *arabica* Priesner, *atroalba* Lepeletier, *balearica* Friese, *belieri* Dours, *clessini* Fedtschenko, *dalmatica* Pérez, *diversipes* Friese, *edwardsii* Cresson, *erschowi* Fedtschenko, *eversmannii* (Dalla Torre & Friese), *festae* Gribodo, *flabellata* Priesner, *forbesi* Cockerell, *holoxantha* Pérez, *libyphaenica* Gribodo, *nigrifacies* Friese, *nigrilabris* Spinola, *pedata* Eversmann, *platti* Timberlake, *retusa* (Linnaeus), *romandii* Lepeletier, *ruficaudis* (Cameron), *schultzei* Friese, *scopipes* Spinola, *senicula* Pérez, *senilis* Eversmann, *spinolana* Priesner, *strauchi* Fedtschenko, *suworzevi* Morawitz, *testaceipes* Morawitz, and *vernalis* Morawitz. This assemblage includes species from the Holarctic region as well as the South African *A. diversipes, ruficaudis,* and *schultzei.* The nearctic species *edwardsii, forbesi* and *platti* are restricted to the western U.S.

Crotchii Species Group

d. Midtarsal brush of male present. e. Midbasitarsal brush of male absent. f. Middistitarsal brush of male well developed (Fig. 13p). j. Disc of S7 of male basally with lightly to darkly sclerotized areas; apodeme about as long as length of disc (Fig. 2a). k. Apex of S8 of male broadly emarginate with four (sometimes two) weakly developed apical projections, submedian projections usually more developed than lateral projections, lateral projections sometimes absent (Fig. 2b, 13o). l. Apex of gonocoxite of male weakly bifid (Fig. 13n) to simple. n. Penis valve apex large and thick, 1.0-1.3 times longer than wide viewed apicodorsally. o. Penis valve bridge long and narrow, 2.0-2.3 times longer than wide, basally emarginate. p. Gradular process of T7 of male well defined.

Included Species. A. (Pyganthophora) crotchii Cresson, *lesquerellae* (Cockerell), and *vannigera*

FIG. 14. *Anthophora* subgenus *Lophanthophora,* males. A-E, G, *A. (L.) porterae;* F, *A. (L.) dispar.* adr = anterior diverging ridge, bcr = basal converging ridge, dl = dorsal lobe of lateral margin, vl = ventral lobe of lateral margin. A, B, Genital capsule, dorsoventral and side views. C, Flabellum, anterior view. D, E, S6 and S7, ventral views. F, S6 and apex of S5 (hair omitted on S6 but included on S5), ventral view. G, S8, ventral view.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Timberlake. The species occur in the Pacific Coast states of the U. S. including Nevada and Arizona.

Rogenhoferi Species Group

d. Midtarsal brush of male absent. e. Midbasitarsal brush of male absent (weakly developed in *A. albosignata*). f. Middistitarsal brush of male present (absent in *leucorhina, rogenhoferi,* and *sichelii*). j. Disc of T7 of male with dark sclerotized areas; apodeme one half the length of disc (Fig. 13i). k. Apex of S8 of male narrowly emarginate with two submedian projections and laterally with a well developed lobe (Fig. 13k). l. Apex of gonocoxite of male moderately to strongly bifid in profile (Fig. 13l). n. Penis valve apex small and narrow, 3.0-4.5 times as long as wide as viewed apicodorsally. o. Penis valve bridge long and narrow about 3 times as long as wide, basally entire (Fig. 13h). p. Gradular process of T7 of male weakly defined.

Comments. Males of *A. albosignata, finitima, ghigii* and *leucorhina* have well developed paraocular marks. Males of *connexiformis, sergia* and *sichelii* have small paraocular marks. All of other males in this group lack paraocular marks which is unusual for *Anthophora* s. l.

Included Species. A. (Pyganthophora) albicilla Pérez, *albosignata* Friese, *andalusica* Pérez, *arida* Brooks, *caroli* Pérez, *cincreus* Friese new combination, *connexiformis* Cockerell, *fascialoides* Brooks, *finitima* Morawitz, *ghigii* Gribodo, *leucophaea* Pérez, *leucorhina* Cockerell, *limassolica* Mavromoustakis, *nigriceps* Morawitz, *nigrifacies* Friese, *orientalis* Morawitz, *pruinosa* Smith, *punctilabris* Pérez, *rogenhoferi* Morawitz, *rubricus* Dours, *sergia* (Nurse), *sichelii* Radoszkowsky, and *ventilabris* Lepeletier. All species of the Rogenhoferi group are Mediterranean and western Asian in distribution.

Lophanthophora new subgenus

Type species: *Anthophora porterae* Cockerell, 1900.

Diagnosis. Distal half of S6 of male with a pair of oblique diverging ridges, basal half with a pair of ridges converging apically (Fig. 14d); apex of gonocoxite of male simple, flattened, hooked ventrad (Figs. 14a, b); pygidial plate and gradular processes present in male (Fig. 15c); male with midtarsal brush sometimes present, midbasitarsal brush usually absent, middistitarsal brush present (Figs. 15a, b, d).

Description. a. Flagellar segment 1 of female equal to length of next 3.8-5.0 segments together (Fig. 7a) (except *A. robusta,* equal to next 3.0 segments), of male to next 3.0-4.2 segments (except *robusta,* equal to next 2.1 segments). b. Face of male with yellow markings (except white in *dammersi* and *neglecta* and all black in *caelebs*), of female black (except *atricilla* with pale markings); mandible of male black (except *agama, turcomanica,* with pale maculae). c. Malar space of female about 3-8 times as wide as long, of male about 3.0-8.5 times as wide as long; flabellum apically with finger-like projections as in Figure 8c (except *caelebs* apically entire); mentum simple basally, without anterior tooth; mentum about .7-.8 as long as prementum; paraglossa about .8-.9 as long as stipes. d. Midtarsal brush of male when present weakly to well developed (Figs. 15a, b, d) (absent in *affinis, agama, amseli, atricilla, biciliata, robusta,* and *turcomanica*). e. Midbasitarsal brush of male usually absent (Fig. 15b) [present in *atricilla, dispar, hispanica,* and *rutilans* (Figs. 15a, d)]. f. Middistitarsal brush of male present (weakly in *caelebs* (Figs. 15a, b, d). g. Hind basitarsus of male simple, without tooth (greatly flattened in *disparilis,* with anterobasal tooth). h. Basitibial plate of male well defined as in Figure 29. i. S6 of male usually entire, sometimes emarginate, distal half with an oblique ridge on each side diverging apically, basal half with same ridges converging apically (basal ridges absent in *disparilis*); disc usually with lateral depression (Fig. 14d). j. Disc of S7 of male broadly emarginate apically (*disparilis* apically produced, rounded), apicolaterally rounded; lateral margin midway with inner ventral lobe and outer dorsal lobe (only dorsal lobe in *disparilis*), in profile as in Figure 14e; base of disc with a pair of protuberances, sometimes represented only by dark sclerotized areas; apodeme at least 1.25 times as long as length of disc. k. S8 of male apically with 2 submedian projections, sometimes a projection on each side of submedian pair; longitudinal sclerotization absent (Fig. 14g). l. Apex of gonocoxite of male simple (weakly bilobed apically in *amseli*), flattened, hooked ventrad (Figs. 14a, b). m. Gonostylus from ventral view 3.0-6.8 times as long as wide (long and narrow in *atricilla,* and *turcomanica,* 20.0 times as long as wide). n. Penis valve apex of moderate length, about 1.0-2.4 times as long as wide viewed apicodorsally. o. Penis valve bridge basally emarginate to entire, 1.6-2.0 times as long as wide (except *disparilis* 1.0, and *rutilans* 2.3-2.6). p. Pygidial plate of male present apically as a median truncate projection, basally expanded and rounded laterally, not carinate, apically emarginate (Fig. 15c); gradular process of T7 of male, well developed. q. First recurrent vein joining submarginal cell 2 near midpoint. r. Sting in repose attaining or slightly surpassing apex of gonostylus, twice as long as gonostylus (occasionally three times). s. Body length 11-20 mm.

Comments and Biology. The species fly from January to July. This subgenus is most closely related to *Pyganthophora* and *Anthophora* s. str. from which it can be separated in the males by the oblique ridges on the distal half of S6, S8 is wider than long (Fig. 14c) without or with weakly developed, lateral and submedian projections on the apex and the shape of the gonocoxite is as stated in the *Diagnosis.* This subgenus is equivalent to the Porterae group of Brooks (1983) in North America.

Etymology. Lophos (Gr.), ridge or crest, indicating the apically diverging ridges on the distal half of S6 of the male, plus *Anthophora.*

Dispar Species Group

b. Labrum of male apically with three projections, median projection emarginate, suggesting that of many *Heliophila* males (Fig. 30l). e. Midbasitarsal brush of male well developed (Fig. 15a), occupying one-third to one-half length of basitarsus. f. Middistitarsal brush of male well developed (Fig. 15a). g. Hind basitarsus of male somewhat round in cross section and dilated. i. S6 of male apically emarginate medially with a large, deep depression on each side of disc (Fig. 14f); S6 of female normal without median subapical projection. j. Disc of S7 of male basally with pair of tooth-like protuberances. k. S8 of male strongly angulate apicolaterally. m. Gonostylus of male round in cross section, about 3.5 times as long as wide. n. Apex of penis valve about 1.6 times as long as wide viewed apicodorsally. o. Penis valve bridge basally emarginate, 1.7 times as long as wide. p. Pygidial plate of male not distinct, represented as a median shelf-like projection, apically wide, about .4 times the distance between the apices of gradular processes. q. First recurrent vein joining submarginal cell 2 distad of midpoint. r. Sting in repose attaining apex of gonostylus, about twice as long as gonostylus.

Included Species and Biology. Included here is only one Mediterranean species, *A. (Lophanthophora) dispar* Lepeletier, the biology of which in Egypt was described by Ibrahim (1976, as *A. speciosa* Friese).

Porterae Species Group

b. Labrum of male medioapically with a weakly emarginate projection, apical margin sometimes flexed outwardly, greatly produced. e. Midbasitarsal brush of male absent (weakly present in *A. atricilla*), though *ursina* and *dammersi* have an apparently different, derived, dense group of flattened, orange hairs in the same position as a basitarsal brush. f. Middistitarsal brush of male weakly to well developed. g. Hind basitarsus of male flattened. i. S6 of male apically entire (sometimes emarginate as in *affinis, agama, biciliata, disparilis, neglecta, robusta, turcomanica,* and *ursina*), with a shallow depression on each side (Fig. 14d) (depression absent in *disparilis*); S6 of female normal, without median subapical projection. j. Disc of S7 of male with a basal pair of dark sclerotized areas and/or tooth-like protuberances (Fig. 14e). k. S8 of male apicolaterally rounded (Fig. 14g). m. Gonostylus of male flattened to round in cross section, short to long, 2.5-8.5 times as long as wide (Figs. 14a, b) (long in *atricilla,* and *turcomanica,* 20 times longer than wide). n. Penis valve apex about as long as wide as viewed apicodorsally. o. Penis valve bridge basally emarginate, 1.6-2.3 times as long as wide, short in *disparilis,* 1.0). p. Pygidial plate of male distinct, apically wide, about 0.3 the distance between apices of gradular processes (Fig. 15c). q. First recurrent vein joining submarginal cell 2 basal to or distal to midpoint. r. Sting in repose attaining or slightly surpassing apex of gonostylus, 2-3 times as long as gonostylus.

Comments. A. disparilis Friese is a strange species in that the male has an all black labrum, greatly flattened hind basitarsus with a tooth and

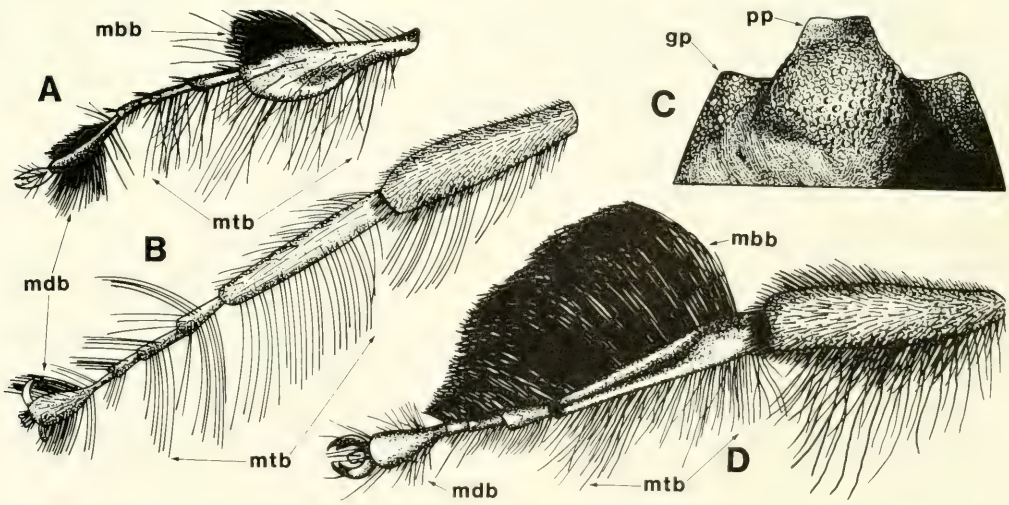


FIG. 15. *Anthophora* subgenus *Lophanthophora,* males. gp = gradular process, mbb = midbasitarsal brush, mdb = middistitarsal brush, mtb = midtarsal brush, pp = pygidial plate. A, Midleg of *A. (L.) dispar,* outer view. B, C, *A. (L.) porterae,* midleg, outer view and apex of T7 (hair is omitted), dorsal view. D, *A. (L.) hispanica,* midleg, outer view.

nontypical S7 and S8 and genital capsule.

Biology. North American species of *Lophanthophora* are active from spring to early summer, that is, from mid January to July (there have been two U. S. specimens collected in August and flight records in Texas as early as November). The palearctic species fly from February to May. All *Lophanthophora* whose habits are known are polylectic, and at least *A. pacifica* overwinters as an adult in Utah (P. Torchio, pers. comm.). In the Old World only the biology of *affinis* (as *radoszkowskyi*) is known (Radchenko, 1984).

Included Species. A. (Lophanthophora) affabilis Cresson, *affinis* Brullé, *aflabellata* Gribodo, *agama* Radoszkowsky, *amseli* Hedicke, *atricilla* Eversmann, *biciliata* Lepeletier, *bifasciata* Fedtschenko, *bogdanowi* Fedtschenko, *caelebs* Gribodo, *clessini* Fedtschenko, *cinerascens* Lepeletier, *coptognatha* Timberlake, *dammersi* Timberlake, *disparilis* Friese, *fedorica* Cockerell, *fratercula* Gribodo, *fuliginosa* Morawitz, *heinemanni* Fedtschenko, *kochi* Fedtschenko, *melanocephala* Fedtschenko, *murutica* Friese, *neglecta* Timberlake & Cockerell, *niveiventris* Friese, *pacifica* Cresson, *porterae* Cockerell, *pretiosa* Friese, *robusta* (Klug), *turcomanica* Morawitz, and *ursina* Cresson. *Lophanthophora* is holarctic and found generally throughout the United States, Europe, north Africa to central Asia.

Hispanica Species Group

b. Labrum of male apically entire or weakly emarginate, median projection present. e. Midbasitarsal brush of male well developed (Fig. 15d), occupying three-fourths length of basitarsus. f. Middistitarsal brush of male weakly developed (Fig. 15d). g. Hind basitarsus of male flattened. i. S6 of male apicomedially entire to weakly emarginate, disc flat without lateral depression; S6 of female with median subapical projection in *A. hispanica.* j. Disc of S7 of male laterobasally with only dark sclerotized area, no tooth. k. S8 of male apicolaterally rounded. m. Gonostylus of male flattened, short, 3.1-4.3 times as long as wide. n. Apex of penis valve as long as wide viewed apicodorsally. o. Bridge of penis valve basally emarginate to entire, 1.6-2.6 times as long as wide. p. Pygidial plate of male distinct, apically wide, about .2 of distance between apices of gradular processes. q. First recurrent vein joining submarginal cell 2 distal to midpoint. r. Sting in repose slightly surpassing apex of gonostylus, twice as long as gonostylus.

Biology. The members of this group fly from March to April.

Included Species. A. (Lophanthophora) hispanica (Fabricius) and *rutilans* Dours. Both are Mediterranean in distribution.

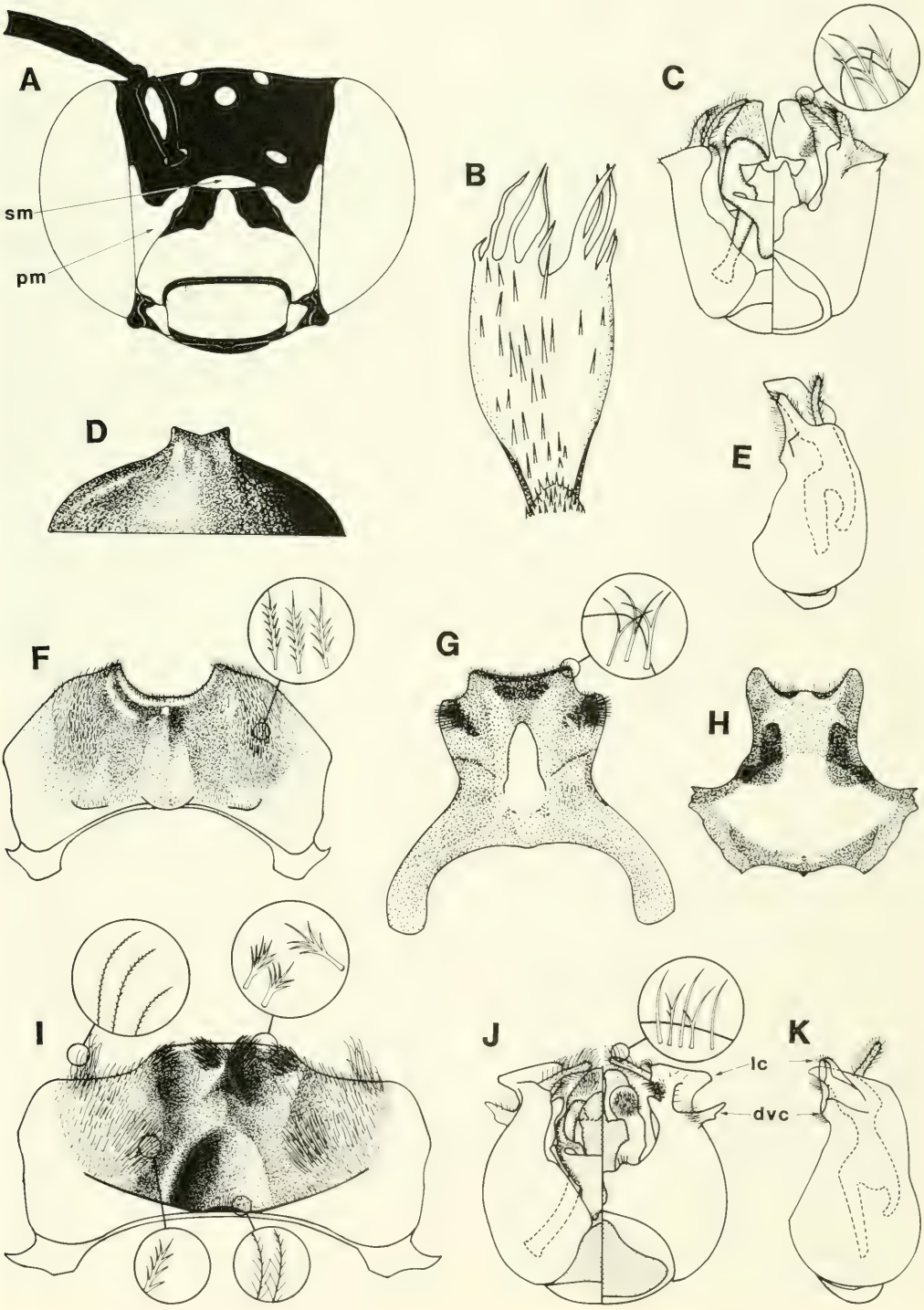
***Mystacanthophora* new subgenus**

Type Species: *Anthophora montana* Cresson, 1869.

Diagnosis. Female with flat or weakly convex face, clypeus in profile at most .8 width of eye; clypeus usually with erect apically hooked or wavy hairs and often basally with a pecten (Figs. 17a-e); male almost always with S5 and S6 greatly modified (see character j and Figs. 16f, i, 17f); apex of S7 of male with two well developed lateral lobes, disc broad and wide, center with an oval clear area (Fig. 16g); S8 of male broadly and deeply emarginate with well developed lateral lobe, base laterally with short tooth (Fig. 16h); apex of gonocoxite of male complex with a lateral and dorsoventral carina (Figs. 16j, k), only dorsoventral carina present in western U. S. species *A. urbana* (Figs. 16c, e); face of male white to creamy white.

Description. a. Flagellar segment 1 of female equal to length of next 2.2-3.0 segments together (*A. paranensis,* 3.4), of male 1.0-2.0 segments. b. Face of male with white markings, occasionally cream-colored; mandible with white spot basally (except the Antillean *tricolor* and *footei* with no basal spot), pale marking on clypeus distinctive with apicolateral black area (Fig. 16a) (except that *boharti, urbana,* and the Antillean *Anthophora* have clypeus completely white except for black spots on anterior tentorial pits); face of female black [except *bahamensis* with white on clypeus (Fig. 40i)]; clypeus often basally with a pecten and usually covered with short, apically hooked or wavy hairs (Figs. 17a-e) (hooked hairs and/or pecten absent on *bahamensis, boharti, borealis, arequipensis, footei, tricolor,* and *urbana*). c. Malar space of female 5-16 times as wide as long, of male 5-10 times as wide as long; flabellum with several apical finger-like lobes (Fig. 16b); mentum simple, without anterior tooth on basal third, mentum .25-.37 as long as prementum; paraglossa .68-.76 as long as stipes. d-e. Midtarsal and midbasitarsal brushes of male absent. f. Middistitarsal brush of male absent (present weakly in *walshii* and *borealis*). g. Hind basitarsus of male simple, without teeth, about three times as long as wide. h. Basitibial plate of male almost always poorly defined to absent (well defined in *capistrata* and *walshii*). i. S6 of male usually broadly emarginate apicomedially, with a lateral depression (Fig. 16f), South American species have apical margin entire or with median, shallow emargination (i.e., *paranensis*), or with median third of apical margin produced, truncate (i.e., *arequipensis*); S5 of male modified with four apical tufts of black hair (Figs. 17f, 41g) or black hair tufts coalesced, forming a thick apical band

FIG. 16. *Anthophora* subgenus *Mystacanthophora,* males. A, B, D, F-K, *A. (M.) montana;* C, E, *A. (M.) urbana.* Hair omitted in A, D. dvc = dorsoventral carinal process, lc = lateral carinal process, pm = paraocular mark, sm = supraclypeal mark. A, Face. B, Flabellum, anterior view. C, E, Genital capsule, dorsoventral and side views. D, Apex of T7, dorsal view. F, S6, ventral view. G, S7, ventral view. H, S8, ventral view. I, S5, ventral view. J, K, Genital capsule dorsoventral and side views.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(Fig. 16i); median third of apical margin broadly produced, truncate (Fig. 16i) [except in *urbana* normal, apical margin entire; *borealis* without black hair, apical margin entire, with a dense transverse band of white hair on basal third; and *boharti* with apical band of brown hair (Fig. 41f)]. j. Disc of S7 of male (Fig. 16g) with apex broadly emarginate [that of *boharti* broadly produced, with apicolateral margin angulate, lateral margin at apical three-fourths with large lobe (Fig. 40c)], basally disc without protuberances or dark sclerotized areas; apodeme short, 0.5-1.0 as long as length of disc. k. S8 of male (Fig. 16h) with apex broadly emarginate medially with a lobe on each side; longitudinal sclerotization usually absent. l. Apex of gonocoxite of male with two plate-like carinae, basal one running dorsoventrally and apical one positioned laterally (horizontally) (Figs. 16j, k) [lateral carina absent in *urbana* (Figs. 16c, e)]. m. Gonostylus of male 6-15 times as long as wide [that of *boharti* short, 2.5 times as long as wide (Fig. 40b), that of *borealis* almost absent, represented only by a small bump]. n. Apex of penis valve 1.1-1.7 times as long as wide as viewed apicodorsally, dorsum of apex covered with short hair, ventrally with a round patch of long hair (Fig. 16j) [round patch of short hair in *boharti* (Fig. 40b) and *borealis*]. o. Bridge of penis valve basally emarginate, about 1.5-2.0 times longer than wide. p. Pygidial plate of male absent but apicomedially a shelf-like, broadly emarginate projection present (Fig. 16d); gradular process of T7 of male absent. q. First recurrent vein joining submarginal cell 2 distal to midpoint. r. Sting in repose significantly surpassing apex of gonostylus (except *urbana* with sting only attaining apex), 2-3 times longer than length of gonostylus. s. Length 9-16 mm.

Comments. The relationship of *Mystacanthophora* to other subgenera of *Anthophora* remains obscure. Perhaps it is related to *Caranthophora,* which it more or less superficially resembles, but I have found no synapomorphies linking any subgenus to *Mystacanthophora.* It can readily be separated from other subgenera of *Anthophora* by the characters given in the *Diagnosis.*

Etymology. Mystacos (Gr.), the hair upon the upper lip, a prefix referring to the modified setae at the base of the female clypeus, plus *Anthophora,* a name of a related taxon.

Montana Species Group

b. Female with face modified as in subgeneric description or occasionally unmodified. i. S6 of male with a median longitudinal rounded ridge, sometimes weakly developed, with a large lateral tuft of black hair (Fig. 16f); S5 of male modified as indicated in subgeneric description (Fig. 16i). l. Apex of gonostylus as indicated in subgeneric description. r. Sting in repose greatly exceeding apex of gonostylus.

Comments. From a study of the type series of *A. arequipensis* and *escomeli,* it became apparent that *escomeli* is the melanic form of *arequipensis.* The females in the series showed intergradation between the pale-haired *arequipensis* and the all black *escomeli.* There are no morphological differences between the two. Dichromatism is not uncommon in *Mystacanthophora;* there are melanic forms of *hilaris* and *tricolor.*

A noteworthy apomorphy of the flat-faced species is the presence of both micro and macrosetae (Fig. 3a) on the clypeus. Other Anthophorini have only macrosetae.

Biology. North American species of *Mystacanthophora* fly from mid April to October and even to mid December in México. Antillean species fly from May to December. Alayo Dalmau (1973) gave a list of Cuban *Mystacanthophora* and Alayo Soto (1982) gives a brief biology of *A. atrata.* Adult activity of South American species is from October to mid July. Gay (1851) gave a list of Chilean *Mystacanthophora.* The nesting biology of two of the South American *Mystacanthophora* is known: *incerta* (Etcheverry and Valenzuela, 1960) and *paranensis* (Janvier, as *incerta* Janvier, 1955; Michener et al., 1958). In the Old World, the biology of only *borealis* (Popova, 1984) is known.

Included Species. A. (Mystacanthophora) albiceps Friese, *andicola* Schrottky, *arequipensis* Brèthes, *atrata* Cresson, *bahamensis* n. sp., *boharti* n. sp., *borealis* Morawitz, *capistrata* Cresson, *dorsalis* Vachal, *footei* Crawford, *hilaris* Smith, *incerta* Spinola, *montana* Cresson, *paranensis* Holmberg, *pilifrons* Packard, *tricolor* (Fabricius), *versicolor* Friese, and *walshii* Cresson. They occur over most of the United States except the southeastern States. Additionally they are found in the southern areas of British Columbia, Alberta, Saskatchewan and Manitoba. The Antillean species, listed by Friese (1902), occur from the Bahamas and Cuba (but not known from Jamaica) to Saint Vincent. The South American species occur from Mérida, Venezuela, south in the Andean zone to about Santiago, Chile and east across northern and central Argentina to southern Brasil. Old World species, *borealis* and *boharti,* occur in Central Europe and Iran to Siberia.

Urbana Species Group

b. Female with unmodified face. i. S6 of male without a median longitudinal rounded ridge and no lateral tuft of black hair; S5 of male not modified. l. Apex of gonostylus of male with dorsoventral carina less developed and lateral carina absent (Figs. 16c, e). r. Sting in repose almost attaining apex of gonostylus.

Comments and Biology. Among *Mystacanthophora* species, *A. urbana* is the one having the most plesiomorphous characters. The female has an

unmodified face and the male has an unmodified S5, S6 and genitalia. *A. urbana* is at least bivoltine (Mayer and Johansen, 1976), flying from the end of March to mid November.

Included Species. A. (Mystacanthophora) urbana Cresson. Even though it is a "primitive" species, it has the largest range of any North American *Mystacanthophora* — Texas and Nebraska (exclud-

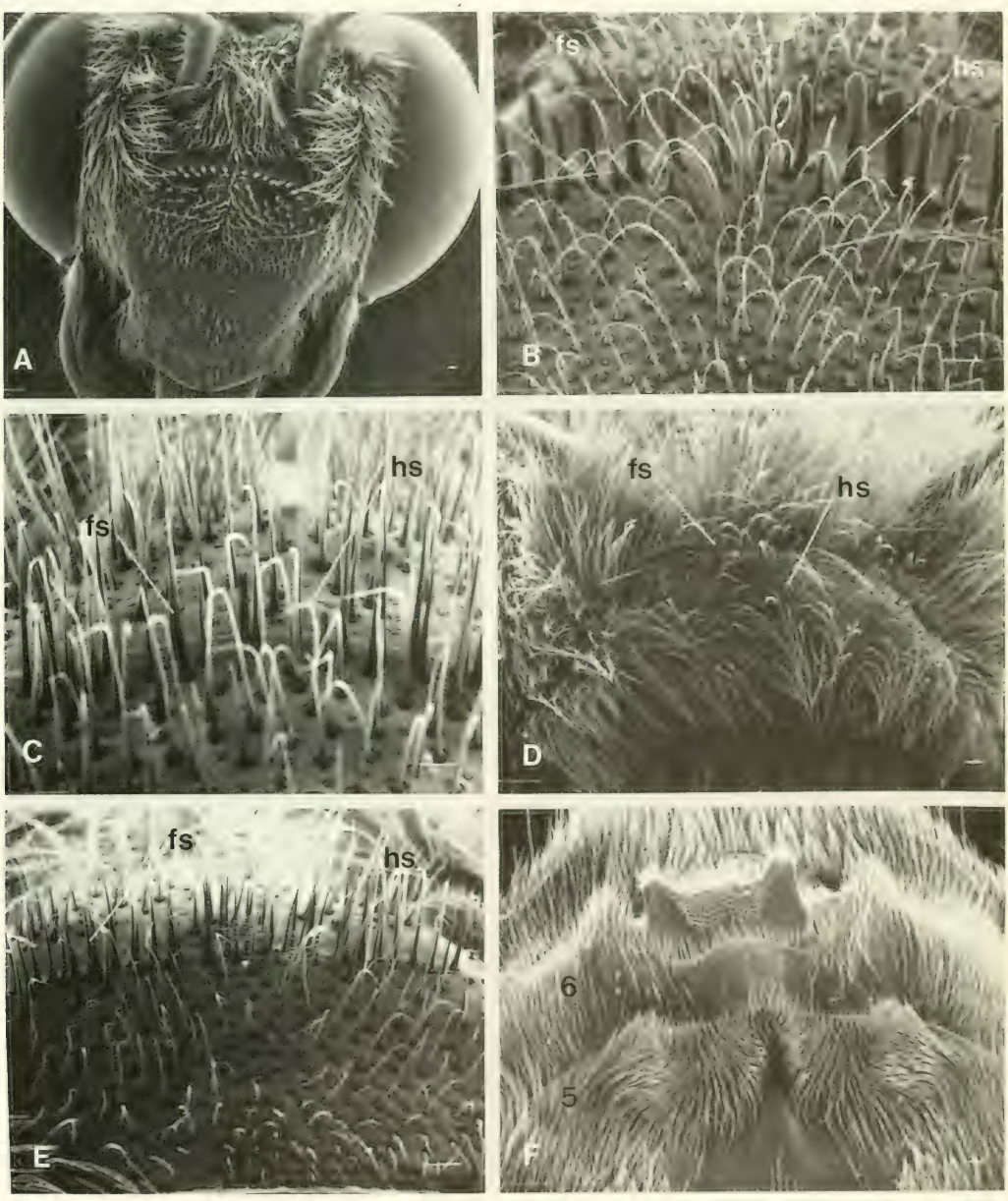


FIG. 17. *Anthophora* subgenus *Mystacanthophora.* Scale lines (on right side) represent .1 mm; fs = flattened or round stout seta. hs = apically hooked seta of pecten. A, B, *Anthophora capistrata* female, face and close up of base of clypeus. C, *A. montana,* base of clypeus of female. D, E, *A. arequipensis* and *A. hilaris,* upper part of clypeus of females. F, *A. walshii,* ventral view of male metasoma showing pattern of pubescence of S5-S6.

ing Kansas and Oklahoma) west to the Pacific Coast (southern British Columbia to Baja California).

Caranthophora new subgenus

Type Species: *Anthophora dufourii* Lepeletier, 1841.

Diagnosis. Clypeus of female with inverted T-shaped pale mark (Fig. 18g) (except the Chinese *A. hedini*); male with midtarsal brush absent, midbasitarsal and middistitarsal brushes well developed (Fig. 18k); posterior margin of inner surface of hind basitarsus with shiny, sparsely setose longitudinal concavity (Fig. 18h); hind tibia and femur of male dilated (Fig. 18i); S7 of male with disc about as wide as long, apodeme short (Fig. 18d); S8 of male broad and short, apicolateral margin with submedian angulate lobe and lateral rounded lobe (Fig. 18c); pygidial plate of male absent, T7 with two submedian, widely separated, apical teeth (Fig. 18j).

Description. a. Flagellar segment 1 of female equal to length of next 2.2-3.0 segments, of male to next 1.2-1.7 segments. b. Face of male with white markings, mandible black (*A. hedini* with mandible white); clypeus of female with inverted T-shaped white mark (Fig. 18g) (brown in *iole,* absent in *hedini*); labrum with pale mark (absent in *A. hedini*). c. Malar space of female 5.5-11.7 times as wide as long, of male 5.0-10.7 times as wide as long; flabellum with several apical finger-like lobes; mentum simple, without anterior tooth on basal third, mentum about .6 as long as prementum; paraglossa about .7 as long as stipes. d. Midtarsal brush of male absent. e-f. Midbasitarsal and middistitarsal brushes of male well developed (Fig. 18k). g. Hind basitarsus of male with or without basal tooth; basitarsus greatly flattened, outward surface broadly concave (Fig. 18i); inner hind basitarsal brush of male not extending to posterior margin, leaving a shiny, sparsely setose longitudinal concavity (Fig. 18h); hind tibia and femur dilated (Fig. 18i). h. Basitibial plate of male absent. i. S6 of male with apex broadly but shallowly emarginate, sometimes with lateral projection on apical margin (only in *dufourii*) (Fig. 18f). j. S7 of male apically broad, narrowly emarginate medially, sometimes with median projection (Fig. 18d); apicolateral margin with smaller dorsal lobe and slightly basal to it a larger ventral lobe, in profile as in Figure 18e; base of disc with lateral dark sclerotized area or tooth; apodeme extremely short, .3-.4 as long as length of disc (Fig. 18d). k. S8 of male apically with 4 projections, submedian pair strongly developed and angulate, lateral pair strongly to weakly developed and rounded (Fig. 18c); longitudinal sclerotization absent. l. Apex of gonocoxite of male, viewed laterally, with 3 projections; gonostylus not borne on any of these projections (Fig. 18b). m. Gonostylus of male, short, flat to round in cross section, 4.8-10.0 times longer than wide. n. Apex of penis valve narrow and small, 2.4-2.8 times as long as wide viewed apicodorsally (Fig. 18a). o. Bridge of penis valves simple, not emarginate, short and wide basally, 0.9-1.5 as long as wide. p. Pygidial plate of male absent; T7 of male apicomedially with 2 widely separated submedian teeth, their length .2-.3 as long as distance between their outer bases (Fig. 18j); gradular process of T7 absent. q. First recurrent vein joining submarginal cell 2 distal to midpoint. r. Sting in repose usually not quite attaining apex of gonostylus (slightly surpassing in *iole*), 2.0-2.5 times length of gonostylus. s. Length 8.5-17.8 mm.

Etymology. Cara (Gr.), face, a prefix referring to the pale marks on the face of the female, plus *Anthophora.*

Comments. Caranthophora apparently is most closely related to *Heliophila* from which its females can be separated by having the posterior margin of the hind tibia with a band of plumose hairs. The males are readily separated by a dilated hind femur and tibia and flattened basitarsus that bears on its anterior surface a basal and an apical tooth, by "brushes" of hair on the midtibia and midtarsus, and by other male characters given in the *Diagnosis.*

Included Species. A. (Caranthophora) dufourii Lepeletier, *hedini* Alfken, *iole* Bingham, *kneuckeri* Alfken, *pubescens* (Fabricius), and *spinacoxa* n. sp. The six species are more or less disjunct. They are found in the Mediterranean and eastern European areas to northern India and eastern China.

Subgenus *Paramegilla* Friese

Paramegilla Friese, 1897, pp. 18 and 25.
Type species: *Apis ireos* Pallas, 1773, designated by Sandhouse, 1943, p. 584.

Solamegilla Marikovskaya, 1980, pp. 650-652. **New Synonym.**
Type species: *Anthophora prshewalskii* Morawitz, 1880 (by original designation).

Diagnosis. Hind basitarsus of male usually with an anterior bump to well developed tooth and/or flattened (Figs. 19g, 20g, j, o); apical margin of S6 of male flexed ventrally, at base of deflection a transverse concavity (Figs. 19h, 20e); male with S7 apically with two or four lobes (Figs. 19e, 20d) and of S8 apicolaterally angulate, lateral margin weakly angulate to almost straight (Figs. 19c, 20c); pubescence of metasoma appressed (Fig. 21e), densely semi-erect or with apical bands interrupted medially (Figs. 21c, d); T7 in male variable but distinctive with two lateral teeth (Figs. 19d, 20h, i, k-m) and pygidial plate without carinate margins [except *A. balneorum* (Fig. 20n) and *femorata*].

Description. a. Flagellar segment 1 of female equal to length of next 2.2-4.0 segments, of male to next 1.5-3.2 segments. b. Face of male with creamy white to light yellow, occasionally bright yellow markings; of female black, sometimes with

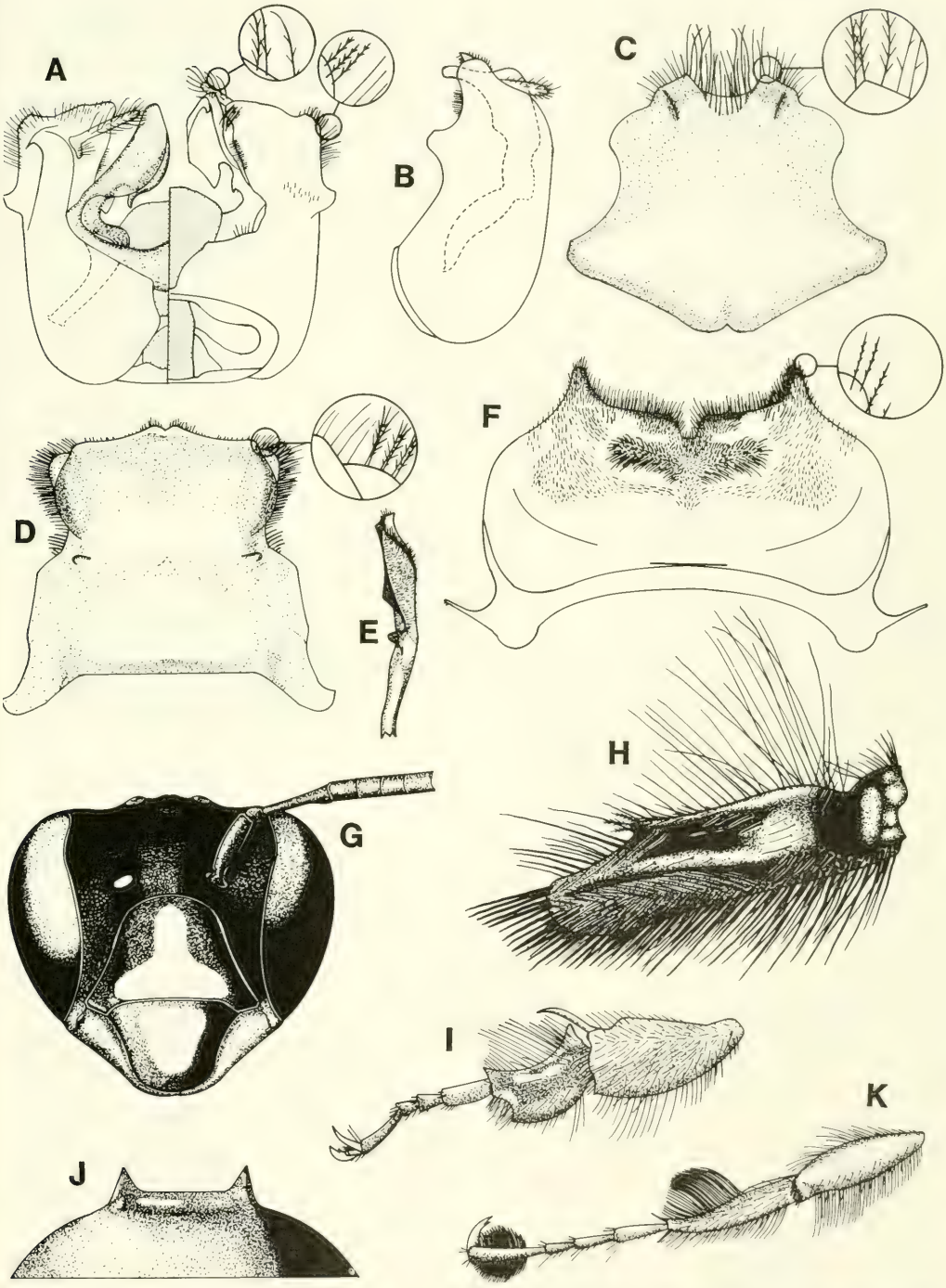


FIG. 18. *Anthophora (Caranthophora) dufourii,* all male except G. A, B, Genital capsule, dorsoventral and side views. C, S8, ventral view. D, E, S7, ventral and side views of disc. F, S6, ventral view. G, Head. H, Hind basitarsus, inner surface. I, Hind leg, outer surface. J, Apex of T7, dorsal view. K, Midleg, outer view.

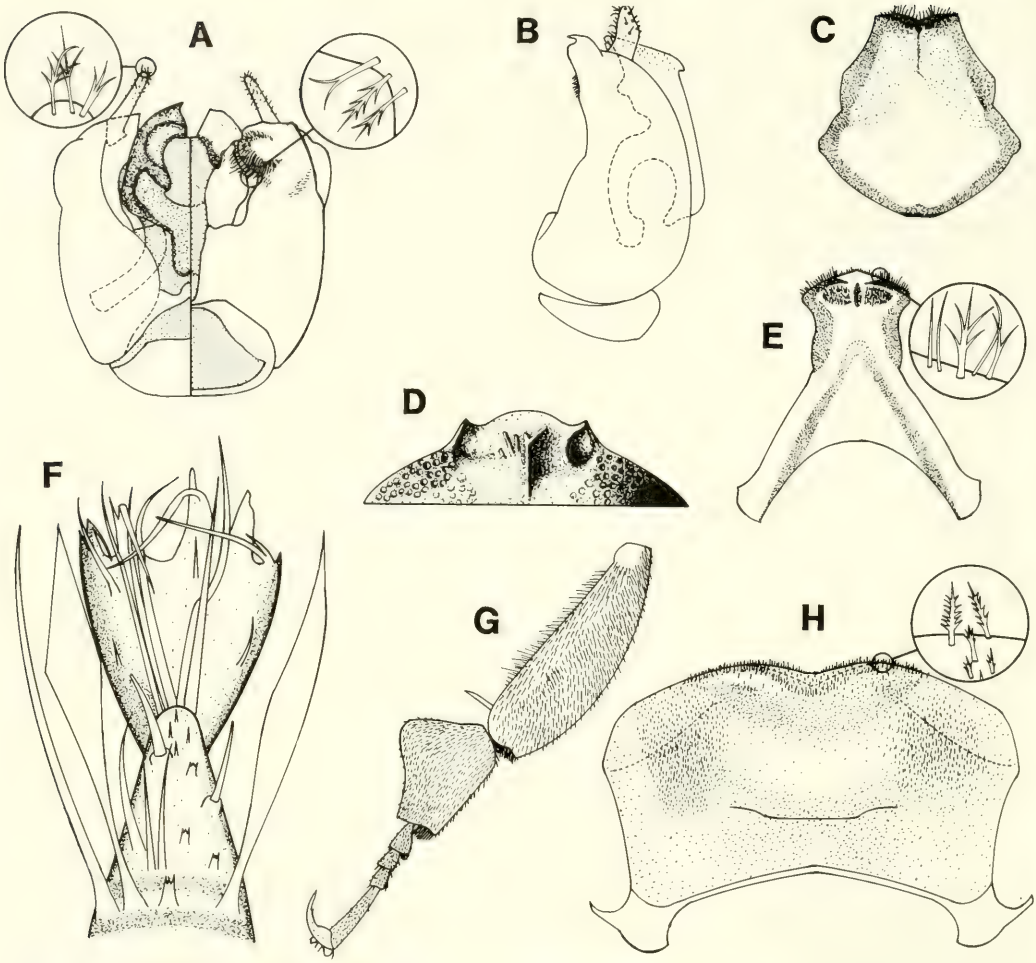
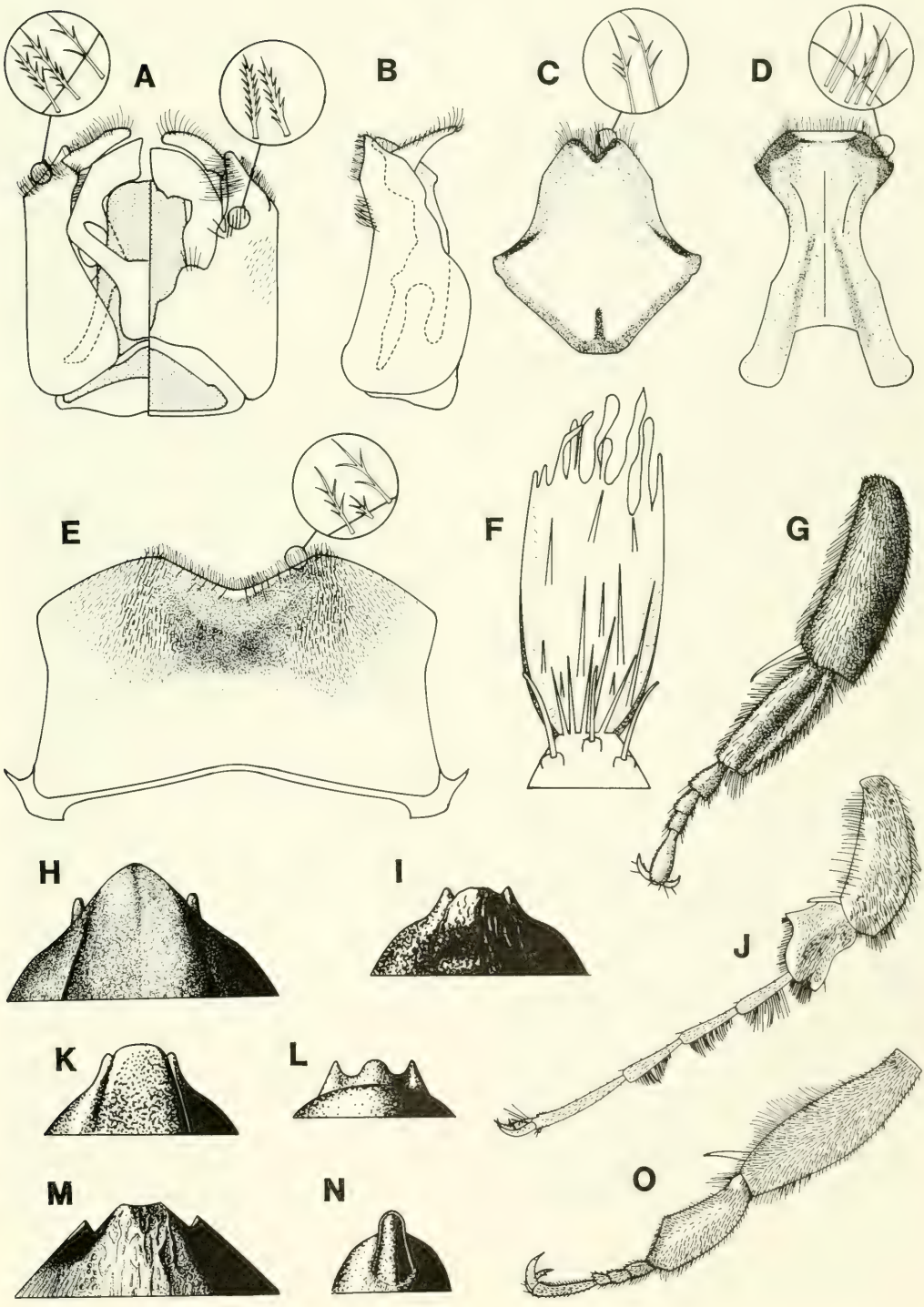


FIG. 19. *Anthophora (Paramegilla) ireos,* male. A, B, Genital capsule dorsoventral and side views. C, S8, ventral view. D, Apex of T7 (hair omitted), dorsal view. E, S7, ventral view. F, Flabellum, anterior view. G, Hind leg, outer view. H, S6, ventral view.

pale marks on clypeus labrum and mandibles. c. Malar space of female 5.5-13.0 times as wide as long; of male 5.7-13.0 times as wide as long; flabellum with several apical finger-like lobes; mentum near basal third simple, without anterior tooth, mentum about .5-.6 as long as prementum; paraglossa about .8 as long as stipes. d-f. Midleg with brushes of male absent. g. Hind basitarsus of male almost always with an anterior bump to a well developed tooth .35-.80 as wide basally as long (Figs. 19g, 20g, j, o) or with an anterior longitudinal ridge (simple in *A. balneorum, A. erubescens,* and *A. ferruginea*); hind tarsus of male sometimes elongated (Fig. 20j); hind tibia and femur of male often dilated, bulbous (Fig. 20j). h. Basitibial plate of male usually absent (present in *A. balneorum, A. eburnea, A. superans,* weakly developed in *A. ferruginea*). i. Apex of S6 of male broadly to narrowly emarginate medially (margin entire in *A. superans*), apical margin

FIG. 20. *Anthophora* subgenus *Paramegilla,* males. A-H, *A. (P.) basalis.* A, B, Genital capsule, dorsoventral and side views. C-E, S8, S7 and S6, ventral views. F, Flabellum, anterior view. G, Hind leg, outer view. H, Apex of T7, dorsal view. I, Apex of T7 of *A. (P.) semirufa,* dorsal view. J, Hind leg of *A. (P.) gracilipes,* outer view. K-N, Apex of T7 of *A. (P.) valga, A. (P.) dubia, A. (P.) vidua,* and *A. (P.) balneorum,* dorsal views. O, Hind leg of *A. (P.) centriformis,* outer view. Apices of T7 (H, I, K-N) are shown with hairs omitted.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ventrally flexed with weak to strong concave transverse depression (Figs. 19h, 20e); S4 of male sometimes with a median "crown" of dense hair (Fig. 21f). j. S7 of male apicomedially emarginate, entire or produced, apically with 2-4 lobes; base of disc without lateral protuberance though weakly sclerotized area sometimes present; apodeme short, .34-.78 times as long as disc (Figs. 19e, 20d) (long in *A. alternans, A. gracilipes,* and *A. maculigera,* 1.2-1.7 times). k. Apex of S8 of male slightly to deeply emarginate medially and angulate; lateral margin more or less straight (Figs. 19c, 20c); longitudinal sclerotization almost always present. l. Apex of gonocoxite of male relatively simple, in profile weakly bilobed to trilobed (Fig. 18b). m. Gonostylus of male usually flattened, 2.0-8.3 times as long as wide (Figs. 19a, b, 20a, b) (gonostylus reduced to small bump in *A. gracilipes*). n. Apex of penis valve 1.0-2.4 times as long as wide as viewed apicodorsally. o. Bridge of penis valve basally emarginate (except *A. femorata, A. ferruginea,* and *A. superans*), length 1.4-2.6 times as long as wide (Figs. 19a, 20a). p. Male usually with well developed pygidial plate almost always with a basal, lateral tooth .06-.20 as long as distance between their outer bases (Fig. 20h), plate without carinate margins [except *A. balneorum* and *A. femorata* (Fig. 20n)], sometimes only with apex narrowly to widely emarginate forming submedian teeth (Fig. 20l), sometimes with median longitudinal carina (Fig. 19d); gradular process of T7 of male absent; metasoma often with appressed (Fig. 21e) or dense semi-erect pubescence or apical bands of hair interrupted medially (Figs. 21c, d). q. First recurrent vein joining submarginal cell 2 distal to midpoint. r. Sting in repose attaining to surpassing apex of gonostylus (surpassing as far as .43 gonostylar length); sting 1.8-2.7 times length of gonostylus. s. Length 9.5-24 mm.

Biology. Species of *Paramegilla* fly from March to August in the Old World, March to early May in the southwestern U. S. The nesting biologies of three Eurasian species of *Paramegilla* have been reported by Ferton (1902, *A. balneorum*) and Marikovskaya (1970, *fedchenkoi* [as *fedtschenkoi*] and *vestitella* [as *vestita*]).

Comments. Paramegilla is closely related to *Melea* and *Anthophoroides.* It differs from *Melea* in the female by having the hind tibia with a blunt posterior distal process and the posterior margin with band of plumose hair (except *A. larvata,* etc.). The males are separated by having the apicolateral margin of S7 rounded or angulate, not with a large rounded lobe, and the base of S8 coming to a simple point, not trilobed. *Paramegilla* is separated from *Anthophoroides* most easily by distribution since *Anthophoroides* is Nearctic and *Paramegilla* is almost completely Palearctic and Ethiopian. The two species of *Paramegilla* that occur in the southwestern U. S. are large (about 14 mm.) and with appressed hair whereas *Anthophoroides* is small (10-12 mm.) and usually with erect to semi-erect hair. *Anthophoroides* and *Melea* have an anterior tooth near the basal third of the mentum and different male terminalia than *Paramegilla.* There are many species groups within *Paramegilla* not discussed here. The best discussion and illustration of structures of *Paramegilla* was by Marikovskaya (1980). Many *Paramegilla* males have the inner orbits more or less parallel (Fig. 21a) but one African group has the inner orbits diverging above and below (Fig. 21b) as in *basalis.* Another group in Central Asia has a peculiar "crown" of hair on S4 of males (Fig. 21f). Many species have medially interrupted apical hair bands on the terga (Figs. 21c, d). A noteworthy species group (e.g., *A. ambitiosa, femorata, larvata*) includes the only known *Paramegilla* in which the females lack plumose hair along the posterior margin of the hind tibia and in which the second segment of the maxillary palpus is about equal in length to the third.

Marikovskaya (1980) separated *Solamegilla* from *Paramegilla* based upon the wide cheeks, strongly projecting clypeus, elongated flagellomere 1, the strongly elongated apicolateral lobes of S7 and S8 and the presence of teeth along the sides of the pygidial plate of males. The wide cheeks are of no value in separating *Solamegilla* from *Paramegilla;* the width of the genae varies greatly among the species of both taxa as she envisioned them. Similarly, the projection of the clypeus varies widely. The type species of *Paramegilla (A. ireos)* and *Solamegilla (prshewalskii)* have the same clypeal protuberance in profile, that is .6 the protuberance of the eye. Marikovskaya used the length of the "second flagellar segment" (= first flagellomere) to separate the taxa. In the species that Marikovskaya placed in *Solamegilla,* the first male flagellomere is equal in length to the next 1.5 segments *(deserticola)* to 3.0 segments *(onosmarum),* the first female flagellomere is equal in length to the next 2.7 segments *(deserticola)* to 4.0 segments (*onosmarum* and *abramowi*). In *Paramegilla* (sensu Marikovskaya) the range in the male is 1.5 segments *(ireos)* to 2.9 *(vidua),* in the female 2.2 *(olgae)* or 2.3 segments *(ireos)* to 3.3 segments *(gracilipes).* The length of the first flagellomere does not separate *Solamegilla* from *Paramegilla* (sensu Marikovskaya) because there is a continuum of lengths which widely overlap between her two taxa. Marikovskaya (1980) also stated that another distinguishing character is the "strongly elongated lateral subapical lobes of 7th sternite and apex of 8th sternite" although in her diagnosis of *Solamegilla* she records this sternum as "oblong, its subapical lobes varying from

rounded, merging with apex, to strongly laterally expanded and tapered in the following series of species. . . . Subapical lobes of 8th abdominal sternite not developed, its apex varying from medium width to narrow and strongly elongated in the following sequence of species. . . .'' The species of *Paramegilla* (sensu Marikovskaya) show the same variation in the apices of S7 and S8. The last character of the male, namely the presence of teeth on the pygidium, is common in both her *Paramegilla* and *Solamegilla,* thus not of value in separating them. For these reasons, I have syn-

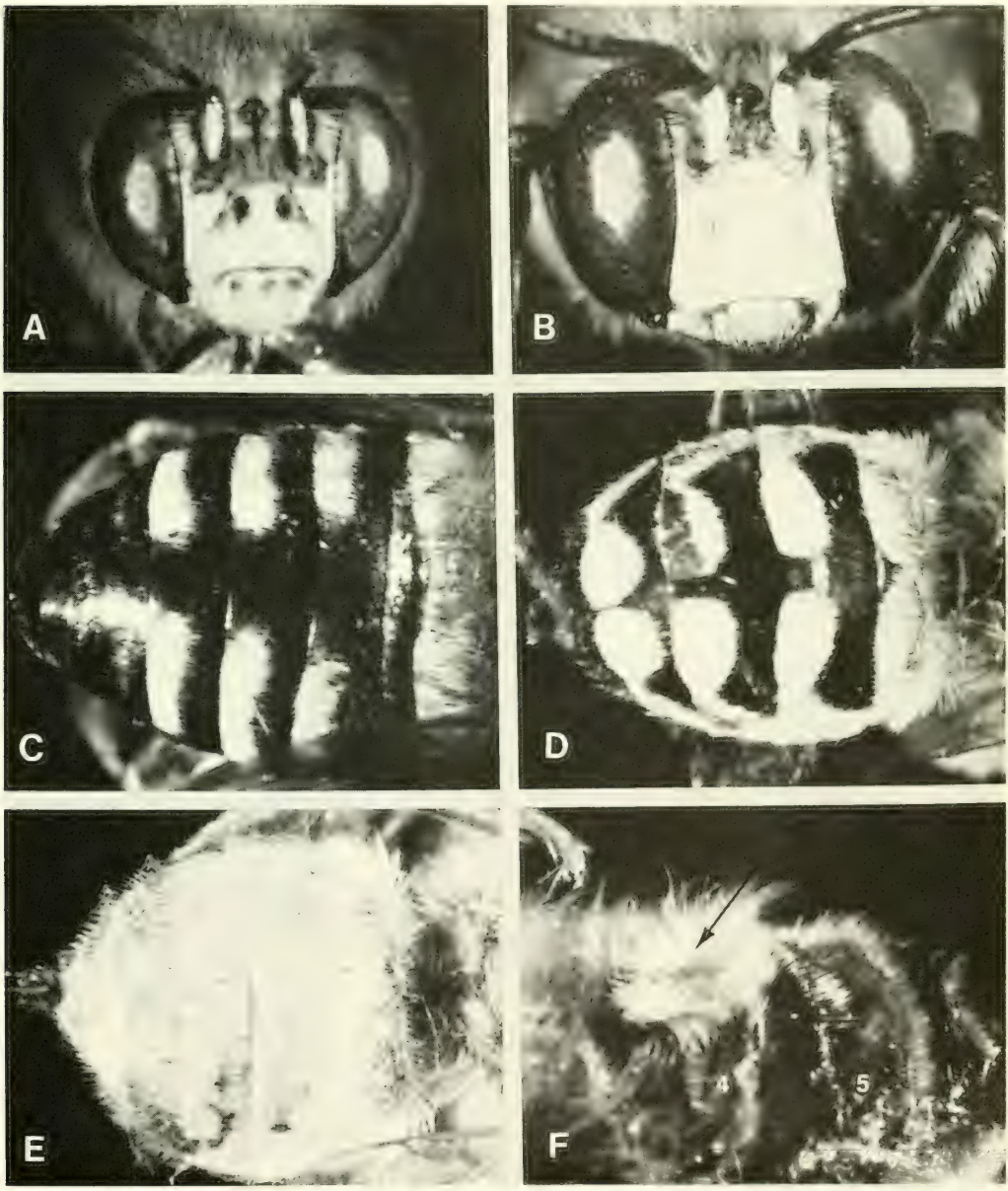


FIG. 21. *Anthophora* subgenus *Paramegilla.* A, *A. gracilipes,* male, frontal view of head. B, *A. semirufa,* male, frontal view of head. C, *A. ireos,* male, dorsal view of metasoma. D, *A. olgae,* female, dorsal view of metasoma. E, *A. martensi,* female, dorsal view of metasoma. F, *A. deserticola,* male, lateroventral view of metasoma, arrow indicates midventral ''crown'' of hair on S4, and numbers sterna.

onymized *Solamegilla* under *Paramegilla.*

Some unique secondary sex characters are noteworthy in *Paramegilla* such as the somewhat serrate antennae of the male of *A. astragali* (Fig. 7c) and the clubbed antennae of the male of *clavicornis* (Fig. 7d).

Included Species. A. (Paramegilla) abramowi Fedtschenko, *alternans* (Klug), *ambitiosa* Alfken, *armata* Friese, *astragali* Morawitz, *balneorum* Lepeletier, *barbipes* Fedtschenko, *basalis* Smith, *blanda* Pérez, *bogutensis* (Marikovskaya), *centriformis* Cresson, *christofi* Morawitz, *clavicornis* Fedtschenko, *concolor* Alfken, *curvicornis* Hedicke, *deserticola* Morawitz, *dubia* Eversmann, *eburnea* Radoszkowsky, *epichariformis* Gribodo, *excelsior* Strand, *fedchenkoi* Radoszkowsky, *femorata* (Olivier), *ferruginea* Lepeletier, *flavescens* Fedtschenko, *flavicornis* Morawitz, *fulvicauda* Timberlake, *fulvipes* Eversmann, *furcotibialis* Wu, *glasunovi* Morawitz, *glaucopis* Friese, *gracilipes* Morawitz, *harmalae* Morawitz, *hirtiventris* Friese, *inclyta* Walker, *ireos* (Pallas), *irregularis* Dours, *kaufmanni* Fedtschenko, *larvata* Giraud, *leonis* Cockerell, *leucopyga* Friese, *maculigera* Priesner, *martensi* Fedtschenko, *melanopyga* Fedtschenko, *meridionalis* Fedtschenko, *mucoriventris* Friese, *olgae* Fedtschenko, *onosmarum* Morawitz, *perezi* Morawitz, *planca* Pérez, *podagra* Lepeletier, *ponomarevae* Brooks, *prshewalskii* Morawitz, *quadricolor* (Erichson), *raddei* Morawitz, *sagemehli* Morawitz, *semirufa* (Friese), *solskyi* Fedtschenko, *spinipes* (Friese), *superans* Walker, *syriaca* Friese, *tarsidens* Fedtschenko, *tedshenensis* Radoszkowsky, *trochanterica* Morawitz, *valga* (Klug), *vestitella* Brooks, and *vidua* (Klug). This subgenus is widespread in Eurasia and Africa, with two species, *centriformis* and *fulvicauda,* in the western United States.

Subgenus *Melea* Sandhouse

Anthemoessa Robertson, 1905, p. 372 (nec Agassiz, 1847).

Type species: *Anthophora abrupta* Say, 1837. Monobasic and original designation.

Melea Sandhouse, 1943, p. 569 (new name for *Anthemoessa* Robertson).

Type species: *Anthophora abrupta* Say, 1837. Autobasic.

Diagnosis. Hind tibia of female with hairs of posterior margin simple, not plumose (Figs. 10e, 22h); hind basitarsus of female with posterior distal process acute (Figs. 22h, 23c); S6 of female with subapical tooth; hind basitarsus of male with anterior margin toothed or angulate (Fig. 22i), male S7 apicolaterally with a large rounded lobe (Fig. 22e) and S8 apically narrowed and basally trilobed (Fig. 22d); mentum near basal third with anterior tooth (Fig. 22k); palearctic species with well to moderately developed malar space as shown in Figure 25h.

Description. a. Flagellar segment 1 of female equal to length of next 2.4-3.0 segments together, of male to next 1.3-1.7 segments. b. Face of male with yellow, of female black; mandible of male with pale mark. c. Malar space of female 3.2-7.8 times as wide as long, of male 2.0-8.4 times as wide as long; flabellum apically with several finger-like lobes; mentum near basal third with anterior tooth (Fig. 22k), mentum about .7-.8 as long as prementum; paraglossa .6-.7 as long as stipes. d-f. Midleg of male with brushes absent. g. Hind basitarsus of male laterally flattened with anterior tooth or ridge (Fig. 22i); hind tibia of female without posterior margin of plumose hair (Fig. 22h), hind basitarsus with distal process acute (Figs. 22h, 23c). h. Basitibial plate of male absent. i. S6 of male apicomedially weakly to strongly emarginate with lightly sclerotized apical area; lateral depression present (Fig. 22f). j. S7 of male apically rounded not emarginate, with large rounded lateral lobe; base of disc without protuberances or dark sclerotized lateral area; apodeme 0.7-1.1 times as long as length of disc (Fig. 22e). k. S8 of male apically with two acute lateral projections, basally trilobed; longitudinal sclerotization absent (Fig. 22d). l. Apex of gonocoxite of male relatively simple, with one long, apical projection and one or two lateral, weakly projecting protuberances (Figs. 22b, c). m. Gonostylus of male flattened, 5-8 times as long as wide. n. Apex of penis valve 1.2-1.7 times as long as wide viewed apicodorsally (Figs. 22b, c). o. Bridge of penis valve basally simple, not emarginate, 0.8-1.5 times as long as wide. p. Pygidial plate of male absent; T7 with two blunt submedian teeth .10-.15 as long as distance between their outer bases; gradular process of T7 of male absent (Fig. 22j); S6 of female with subapical tooth. q. First recurrent vein joining submarginal cell 2 distal to midpoint. r. Sting in repose not attaining apex of gonostylus, twice as long as gonostylus. s. Length 13-17 mm.

History. In 1905 Robertson proposed the generic name *Anthemoessa* for *Anthophora abrupta* Say, using the greater breadth of submarginal cell 3 as the principal key character for the female, and the toothed hind basitarsus for the male. The name *Anthemoessa* had been used previously by Agassiz (1847) as an emendation for a Lepidopteran genus, hence the replacement name *Melea* was proposed by Sandhouse (1943).

Timberlake (1951) believed that *Anthophoroides* was applicable not only to *Anthophora vallorum* (Cockerell) but also to *Melea.* Knowing that the breadth of submarginal cell 3 was valueless, he relied mainly on the length of the first flagellomere, the amount of development of the malar space, and sex-limited characters such as the presence or absence of a tooth on the hind basitarsus and a fringe of dense, often long hair on the middle tarsus of the male to separate

Anthophora s. str. (in his sense) from *Anthophoroides*. Timberlake's idea of *Anthophora* s. str. did not include *Heliophila (=Micranthophora), Amegilla,* or *Clisodon* which he considered genera. Timberlake was the first to recognize the similarities between *Melea* and *Anthophoroides*.

Comments. Melea is most closely related to *Anthophoroides*. Even though the two share derived characters such as the short first flagellomere, the mentum with an anterior tooth near the basal third, the hind basitarsus of the male with an anterior tooth, and similar male terminalia as well as plesiomorphous male characters such as lack of midtarsal, midbasitarsal, and middistitarsal brushes, they are distinct groups. *Melea* can be separated from *Anthophoroides* in the females by the hind tibia with the scopal hairs all simple, S6 with a subapical tooth and the posterior distal process of the hind tibia acute. The males can be separated by their larger size (13-17 mm.), the widely diverging rather than almost parallel apodemes of S7, the trilobed rather than rounded base of S8, and the blunt rather long and acute tooth of the hind basitarsus.

Biology. Melea fly from March to August or September. Several derived biological characters

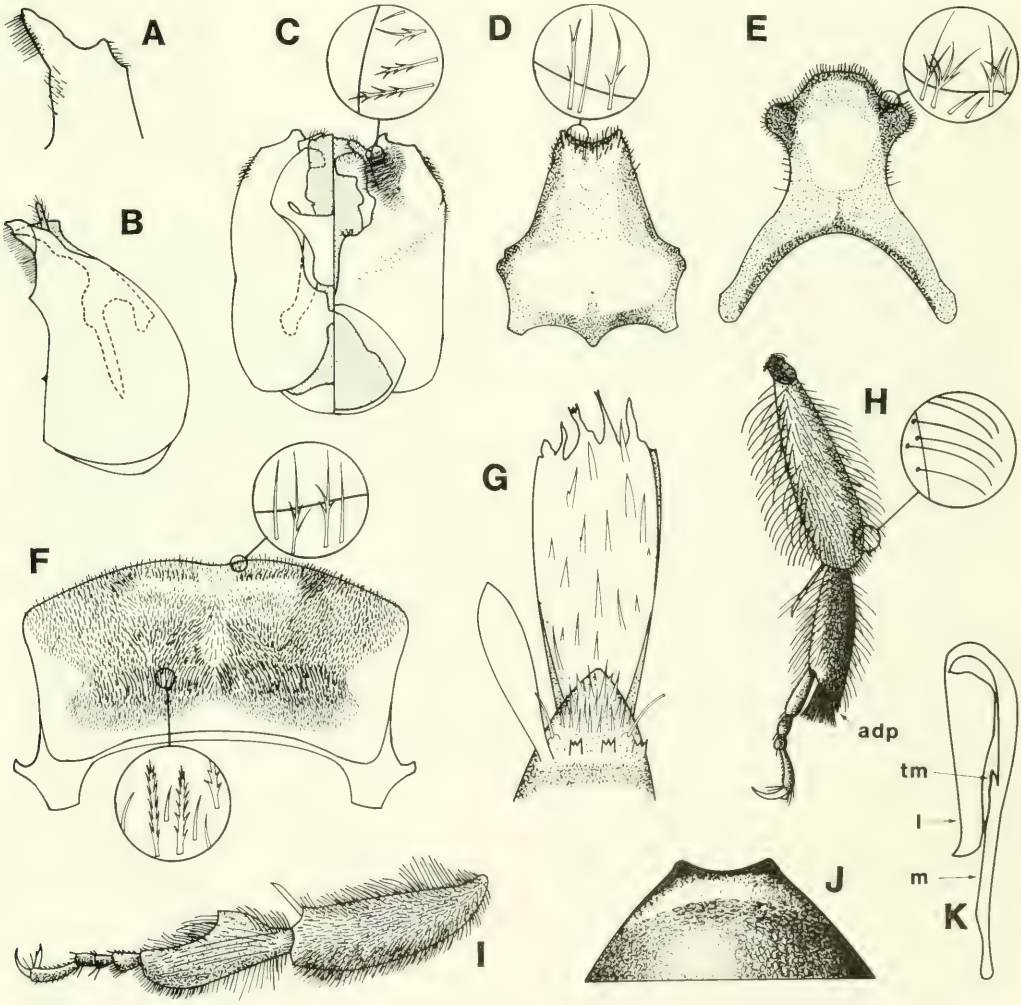


FIG. 22. *Anthophora* subgenus *Melea*. adp = acute distal process of female hind tibia, l = lorum, m = mentum, tm = tooth of mentum. A, *A. (M.) plagiata,* apex of gonocoxite, ventral view of right side. B-K, *A. (M.) abrupta*. B, C, Genital capsule, side and dorsoventral views. D-F, S8, S7 and S6 of male, ventral views. G, Flabellum, anterior view. H, I, Hind leg of female and male, outer views. J, Apex of male T7 (hair omitted), dorsal view. K, Lorum and mentum, side view.

are unique to *Melea* separating it from other taxa in *Anthophora*. These include construction of turrets over the nest entrances and the apparent loss of stinging behavior (Brooks, 1983). All of the species of *Melea* are apparently mimics of bumble bees.

Bomboides Species Group

c. Malar space of female 5.5-7.8 times as wide as long (similar to Fig. 12e), of male 5.7-8.4 times. g. Hind basitarsus of male with large tooth on basal half, tooth .42-.54 as wide basally as long (Fig. 22i). l. Apex of gonocoxite of male with a lateral tooth in addition to apical projection (Fig. 22b).

Comments and Biology. This species group is mainly North American with one Chinese species. Brooks (1983) has discussed the systematics and reviewed the literature on and biology of the nearctic species of *Melea* as the Bomboides species group. Additionally, Norden and Scarbrough (1982) reported on the biology of *A. abrupta*. The males of *A. abrupta* and *nigrifrons* are unique among all other species of Anthophorini in that the labrum has an apical brush of fine flattened adsorptive hairs. The males of *abrupta* chew parsnip (*Pastinaca sativa* L.) tissue, collect the juice in the labral brush, presumably mixing it with mandibular gland secretion, and apply it to objects outlining their territorial paths (Norden and Batra, 1985).

Included Species. A. (Melea) abrupta Say, *bomboides* Kirby, *nigrifrons* Cockerell, and *occidentalis* Cresson. *A. nigrifrons* occurs in southeastern China; the other species are North American and they range far into the Arctic and are found throughout the United States, British Columbia and most of Alberta. With *Clisodon* and *A. (Mystacanthophora) borealis*, they are the only boreal *Anthophora*.

Plagiata Species Group

c. Malar space of female about 3 times as wide as long, of male 2.0-3.8 times (similar to Fig. 25h). g. Hind basitarsus of male with small tooth on apical half, tooth .33-.37 as wide basally as long. l. Apex of gonocoxite of male with two lateral teeth in addition to apical projection (Fig. 22a).

Biology. Important papers concerning palearctic *Melea* are about *A. plagiata* (reported as *parietina*) such as Banaszak (1971), Cros (1936, reported as *romandii*), Marikovskaya (1970), Móczár (1961a, b), Nielsen (1902), Radović and Krunić (1977), Tiede (1920), Verhoeff (1892a) and Wesenburg-Lund (1890). *A. plagiata* may have potential as a manageable pollinator of vetches such as *Vicia villosa* (Wójtowski, 1964). The only other palearctic species whose biology is known is *A. ferreola* (Piel, 1935).

Included Species. A. (Melea) cinerithoracis Wu, *ferreola* Cockerell, *mangkamensis* Wu, *obtusispina* Wu, and *plagiata* (Illiger). The range is from central Europe to China.

Subgenus *Anthophoroides* Cockerell and Cockerell

Anthophoroides Cockerell and Cockerell, 1901, p. 48. Type species: *Podalirius vallorum* Cockerell, 1896. Monotypic and original designation.

Diagnosis. Length 10-13 mm; male with spine on hind tibia anteroapically, with a tibial spur inserted on apical third of spine (Figs. 24i, j); hind basitarsus of male with anterior tooth (Figs. 24i, j); S7 of male apicolaterally with wide rounded lobe, apodemes almost parallel to each other (Fig. 24 d); S8 apicolaterally with angulate submedian lobe and rounded lateral lobe, basally rounded, spiculum long, projecting at right angle from disc (Fig. 24g); gonocoxite of male darkly sclerotized apically (Fig. 24f); mentum near basal third with anterior tooth like species of *Melea* (Fig. 22k).

Description. a. Flagellar segment 1 of female equal to length of next 2.50-3.33 segments together; of male to next 1.33-1.50 segments. b. Face of male with white (yellow in *A. vallorum* and *californica*), of female black (except white marks on *signata*). c. Malar space of female 6.3-8.7 times as wide as long (*vallorum* 13 times), of male 7.0-11.3 times as wide as long; flabellum apically with several finger-like lobes; mentum with anterior tooth near basal third (Fig. 22k), mentum about .5-.7 as long as prementum; paraglossa about .5-.8 as long as stipes. d-f. Midleg with brushes of male absent. g. Hind basitarsus of male with anterior tooth, upper anterior margin of tooth straight to curved (Figs. 24i, j); hind tibia of male dilated with anterior, apical spine, one tibial spur inserted on spine near apex (Fig. 24j); hind femur of male usually dilated, bulbous (Fig. 24j). h. Basitibial plate of male absent. i. S6 of male with apex narrowly emarginate medially, lightly sclerotized; lateral depression present (Fig. 24a). j. S7 of male apically round with broad lateral lobe, profile as in Figure 24e; disc basally without protuberances or dark sclerotized areas; apodeme 1.0-1.3 as long as length of disc (Fig. 24d). k. S8 of male apically with dark sclerotized, ventrally projecting, submedian pair of lobes (Fig. 24g), apicolateral corner weakly developed and rounded, profile of S8 as in Figure 24h; longitudinal sclerotization absent (Fig. 24g). l. Apex of gonocoxite of male apparently simple, though apical lobe with subapical lateral lobe weakly developed, sometimes gonocoxite appearing weakly bilobed, laterally angulate and dark sclerotized (Figs. 24c, f). m. Gonostylus of male 5.0-6.7 times as long as wide. n. Apex of penis valve small, 0.9-1.6 times as long as wide as viewed apicodorsally. o. Bridge of penis valve

basally simple, 0.75-1.10 times as long as wide (Fig. 24f). p. Pygidial plate of male absent; T7 of male with two short submedian teeth .14-.26 as long as distance between their outer bases (Fig. 24b); gradular process of T7 of male absent. q. First recurrent vein joining submarginal cell 2 distal to midpoint. r. Sting in repose not attaining to surpassing apex of gonostylus, 2.2-3.0 length of gonostylus. s. Length 10-13 mm.

Comments. T. D. A. and W. P. Cockerell named *Anthophoroides* because of the five-segmented maxillary palpi. This character is only of value at the specific level, being found also in *A. (Paramegilla) fulvicauda* and in many *Heliophila.* Timberlake (1951) included species of *Melea* with *Anthophoroides* (see *Comments* under *Melea*). *Anthophoroides* is most closely related to *Melea* and its separation from that subgenus is discussed in the *Comments* on *Melea.*

Biology. Species of *Anthophoroides,* a New World subgenus, are xerophilic. Linsley (1942) gave a detailed account of the biology of *A. linsleyi.* Gilliam et al. (1984) analyzed the microbial fauna of an undescribed species of *Anthophoroides.* The territorial behavior of the males of *Anthophoroides* is the same as that of *Melea* in that territories with distinct boundaries, usually enclosing host plants, are defended against conspecific males. The females of *Anthophoroides* nest aggregatively in earthern banks except *signata* which nests in dead Joshua tree stumps *(Yucca)* (R. Snelling, pers. comm.) and possibly also in the ground (Brooks, unpublished). They are generally polylectic though *phaceliae* is oligolectic on *Phacelia* (Hydrophyllaceae).

The species which inhabit the regions of the Sonoran and Colorado desert are probably univoltine but possibly bivoltine. There is a normal spring brood(s?) from February (two records in January) to mid July. In those dry areas which have mid to late summer rains such as southeastern Arizona, *californica* has a second brood. *A. marginata,* the only truly neotropical species, is seasonal in southwestern Arizona and probably in the seasonally dry tropical areas of México but may be multivoltine in other Mexican and Cen-

FIG. 23. *Anthophora* subgenera *Melea* and *Mystacanthophora,* females. Scale lines (on right side) represent .1 mm; dp = posterior distal process. A, B, Basitibial plates of *Anthophora (Melea) abrupta* and *A. (Mystacanthophora) capistrata.* C, D, Outer view of apex of hind basitarsus, *A. (Melea) abrupta* and *A. (Mystacanthophora) capistrata.*

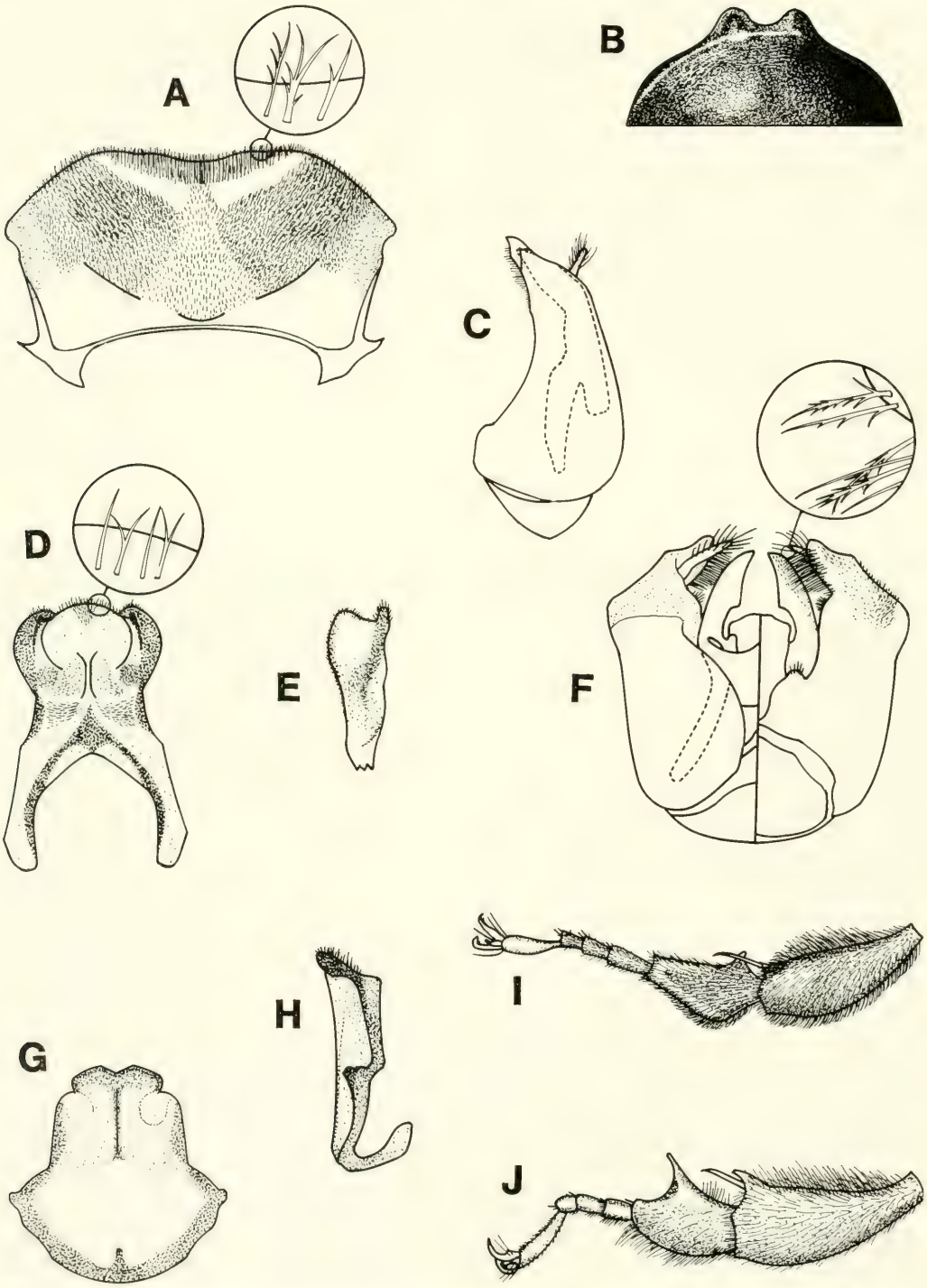


FIG. 24. *Anthophora* subgenus *Anthophoroides,* males. A-I, *A. (A.) vallorum.* A, S6, ventral view. B, Apex of T7 (hair omitted), dorsal view. C, Genital capsule, side view. D, E, S7, ventral and side views of disc. F, Genital capsule, dorsoventral view. G, H, S8, ventral and side views. I, Hind leg, outer view. J, Hind leg of *A. (A.) californica,* outer view.

tral American areas.

Included Species. A. (Anthophoroides) californica Cresson, *linsleyi* Timberlake, *marginata* Smith, *phaceliae* n. sp., *signata* n. sp., *vallorum* (Cockerell), and six undescribed species. They range from Colorado and Texas west to southern Oregon and California, south through México (including Baja California) to Honduras. *A. californica* and *marginata* are the only two species of the twelve which range into the neotropics.

Subgenus *Anthomegilla* Marikovskaya

Anthomegilla Marikovskaya, 1976a, p. 55.

Type species: *Anthophora arctica* Morawitz, 1883. Original designation.

Diagnosis. Malar space well developed, about twice as wide as long (Fig. 25h); male with apically trilobed labrum (Fig. 25i); apodemes of S7 of male short, widely spaced and diverging (Fig. 25e); S8 of male with long apodemes and spiculum projecting anterodorsally in the same plane as disc (Figs. 25b, c); apex of penis valve without fine, small hairs; female with hairs of posterior margin of hind tibia simple (similar to Fig. 10e); flabellum apically entire, apical half to two-thirds narrow and elongate (Fig. 25d).

Description. a. Flagellar segment 1 of female equal to length of next three to four segments together, of male to next 2.0-2.5 segments. b. Face of male with light yellow-white; face of female black; apical margin of male labrum trilobed, median lobe emarginate (Fig. 25i). c. Malar space of female about 1.7 times as wide as long, of male 1.6-2.0 times as wide as long (Fig. 25h); mentum about .7 as long as prementum,

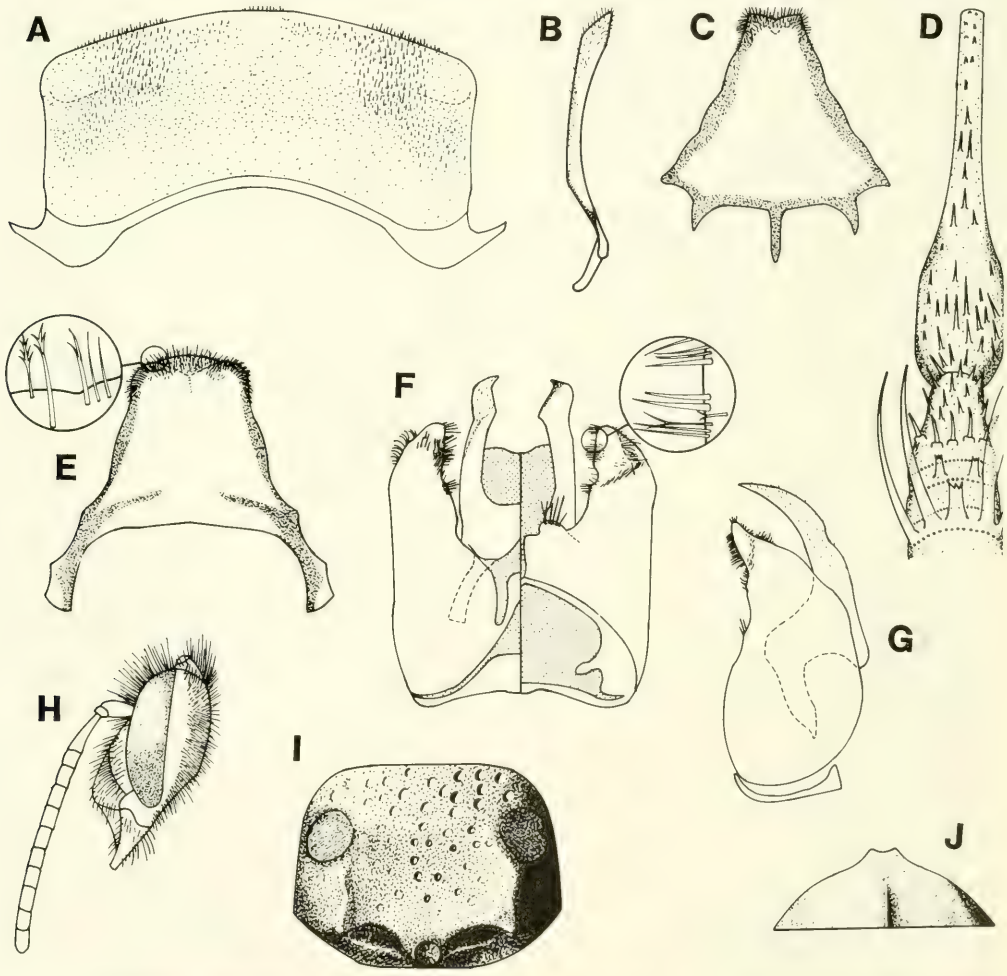


FIG. 25. *Anthophora (Anthomegilla) arctica,* male. A, S6, ventral view. B, C, S8, side and ventral views. D, Flabellum, anterior view. E, S7, ventral view. F, G, Genital capsule, dorsoventral and side views. H, Head, side view. I, Labrum. J, Apex of T7 (hair omitted), dorsal view.

without anterior tooth near basal third; paraglossa about .7-.9 as long as stipes; flabellum apically entire, distal half to two-thirds narrowed, elongate and almost parallel-sided (Fig. 25d). d-f. Midleg with brushes of male absent. g. Hind basitarsus of male simple; female with hairs of longitudinal posterior zone on hind tibia simple (similar to Fig. 10e). h. Basitibial plate of male absent. i. S6 of male apically entire, almost all hair simple except a few apicolateral hairs (Fig. 25a). j. Apex of S7 of male rounded, apicolateral margin weakly developed, apodeme .9 length of disc; base of disc without lateral protuberance or dark sclerotized areas (Fig. 25e). k. S8 of male apicolaterally angulate, longitudinal sclerotization absent, apodemes and spiculum long, both spine-like, projecting anterodorsally and in the same place as the disc (Figs. 25b, c). l. Apex of gonocoxite of male simple, with one blunt projecting lobe as viewed in profile (Fig. 25g). m. Gonostylus of male essentially absent (completely lost in *A. latigena*), only the base remaining as a blister with hairs on inner surface of gonocoxite (Fig. 25f). n. Apex of penis valve 3 times as long as wide as viewed apicodorsally, without hair (Fig. 25g). o. Bridge of penis valve with deep emargination (*latigena* with a pair of protuberances on bridge), emargination .3 times as long as wide (Fig. 25f). p. Pygidial plate of male absent; apex of T7 of male with 2 blunt submedian teeth and basally with a median longitudinal ridge not attaining apical margin; gradular process of T7 of male absent (Fig. 25j). q. First recurrent vein joining submarginal cell 2 distal to midpoint. r. Sting in repose slightly surpassing apex of gonostylus, 1.8 times as long as gonostylus. s. Length of female 11-14 mm, of male 9-13 mm.

Comments. Anthomegilla is closely related to *Rhinomegilla* from which it is separated by the flabellum being apically entire, the apical half to two-thirds narrowed and parallel- sided. The males are separated by the additional characters of the apex of T7 having a median pair of short blunt teeth and S8 with long apodemes and spiculum directed basally.

Marikovskaya (1976a, b) indicated that the volsellae lie free from the gonocoxite in *Anthomegilla.* Upon examination of what she called the volsellae [=ventral lobe of the gonocoxite (Michener, 1944)], I found that their apices are melanized but their bases lightly sclerotized, giving the impression of separation when in fact these structures are connected to the gonocoxites. This condition of apical sclerotization accompanied with basal desclerotization is found in varying degrees in other *Anthophora* but is apparently most highly developed in *Anthomegilla.*

Biology. It appears probable that *Anthomegilla* and some *Rhinomegilla* may be mimics of bumble bees, as is *Melea,* since the orange-yellow pubescence is strikingly similar to that of sympatric bumble bees. The adults are active from June to July.

Included Species. A. (Anthomegilla) arctica Morawitz, *auripes* Morawitz, *beijingensis* (Wu), *carinulata* Morawitz, *crysocnemis* Morawitz, *latigena* Morawitz, *metallica* Morawitz and *wuae* Brooks. This subgenus occurs from central Asia to China. *A. arctica* occurs in the forest zone of Siberia and at high elevations [9000 feet (2743 m) or higher], in the mountains of Soviet Central Asia (Gurvich, 1931), in Mongolia, and in Xizang Province (Tibet), China (Wu, 1982).

Rhinomegilla new subgenus

Type species: *Anthophora megarrhina* Cockerell, 1910.

Diagnosis. Malar space a little longer than wide; mouthparts extremely long, galea in repose surpassing hind coxa, length of glossa 14-15 mm; flabellum broom-shaped, apically with numerous short lobes (Fig. 26b); genital capsule with a projection mesad and a membranous area laterad of ventral lobe of gonocoxite (Fig. 26h), penis valve elongate and narrow (Fig. 26g), bridge of penis valves basally acute, prolonged as narrow projection (Fig. 26h); hind tibia of female with posterior longitudinal margin having simple hair as in Figures 10d, e.

Description. a. Flagellar segment 1 of female about equal to length of next four segments together, of male about equal to next 3 segments. b. Face of male with yellow, of female black, mandible black; clypeus of male in profile projecting 1.7 width of eye; galea long (11-12 mm), in repose surpassing hind coxa, glossa 14-15 mm in length. c. Malar space a little longer than wide (Fig. 26c); flabellum apically with numerous short lobes (Fig. 26b); mentum without anterior tooth near basal third, about .9 as long as prementum; paraglossa about .5 as long as stipes. d-f. Midleg with brushes of male absent. g. Hind basitarsis of male simple; hind tibia of female with posterior longitudinal margin having simple hair as in Figures 10d, e. h. Basitibial plate of male absent. i. S6 of male apically entire, apical margin flexed ventrad (Fig. 26a). j. S7 of male apically entire; apicolateral margin with two weak lobes, a ventral lobe and slightly basal to it a dorsal lobe; apodeme long; slightly longer than length of disc (Fig. 26d). k. S8 of male apically narrowed, bilobed, lateral margin weakly angulate, almost straight; longitudinal sclerotization absent (Fig. 26e). l. Apex of gonocoxite of male simple, with weak ventral projection; with a projection mesad and a membranous area laterad of ventral lobe of gonocoxite (Figs. 26g, h). m. Gonostylus of male 8 times as long as wide. n. Apex of penis valve elongate and apically narrowed (Fig. 26g), about 3.7 times as long as wide as viewed apicodorsally. o. Bridge of penis valves basally prolonged as a sharp point, about twice as

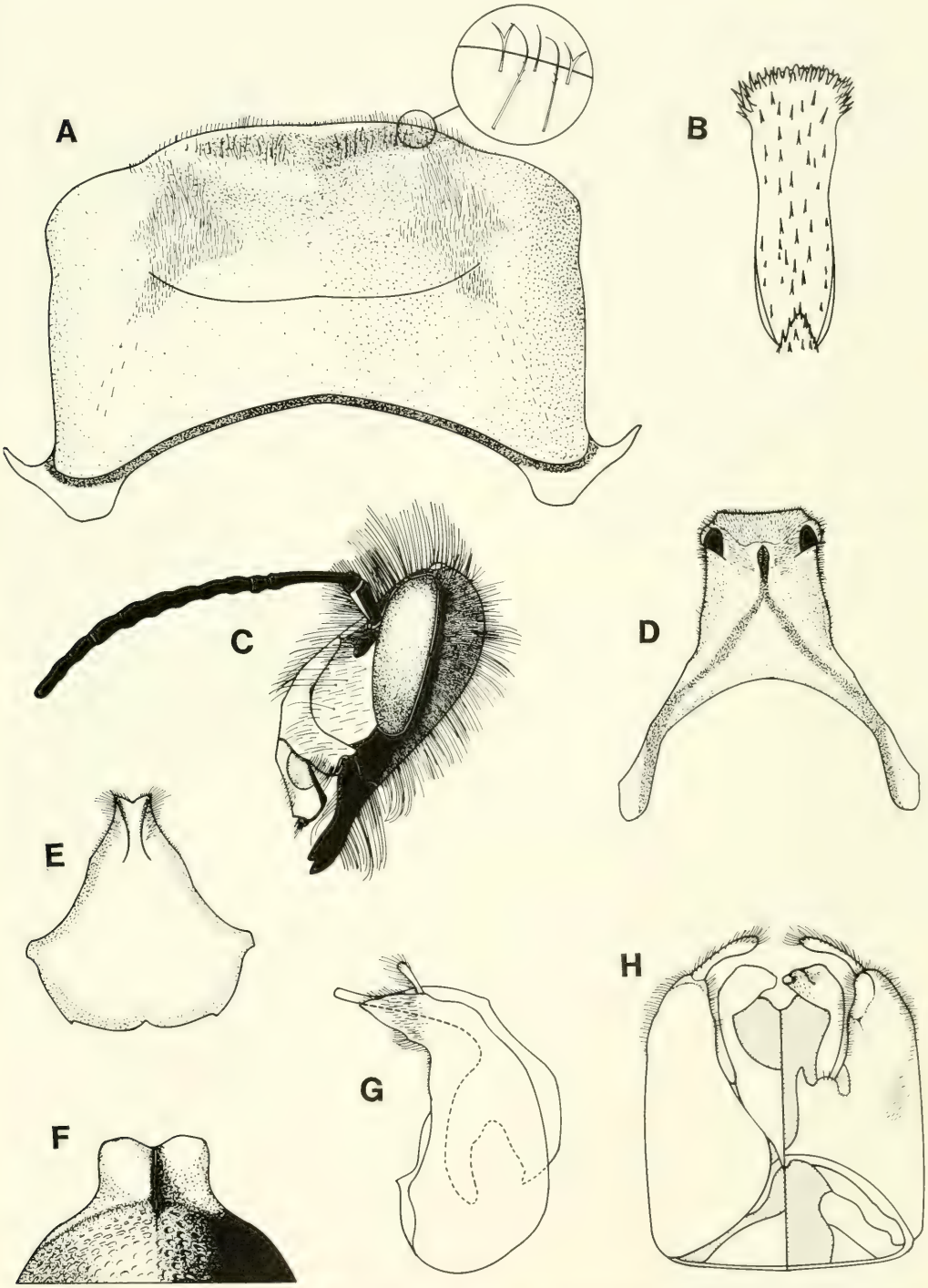


FIG. 26. *Anthophora (Rhinomegilla) megarrhina,* male. A, S6, ventral view. B, Flabellum, anterior view. C, Head, side view. D, E, S7 and S8, ventral views. F, Apex of T7 (hair omitted), dorsal view. G, H, Genital capsule, side and dorsoventral views.

long as wide (Fig. 26h). p. Apex of T7 of male medially with a shelf-like, emarginate process, longitudinally divided by a median carina from apex to slightly past base of process (Fig. 26f); gradular process of T7 of male absent (Fig. 26f). q. First recurrent vein joining submarginal cell 2 distal to midpoint. r. Sting in repose slightly surpassing apex of gonostylus, about 1.8 times as long as gonostylus. s. Female length 8-20 mm, male length 8-19 mm.

Etymology. Rhinos (Gr.), nose, a prefix referring to the protuberant face, plus *Megilla,* a name of a related taxon.

Comments. Rhinomegilla is closely related to *Anthomegilla* but can be separated from that subgenus by the form of the flabellum and in the males by the additional characters of T7 (with an apicomedian shelf-like process), by the elongate narrowed penis valves and by the short apodemes and spiculum of S8 which is apically narrowed. Although *A. megarrhina* is almost completely black, some specimens have pale hair interspersed with black on the propodeum, metasomal sterna and T4 and 5; also the face and anterior half of the scutum sometimes have brownish-black hair.

Biology. Rhinomegilla flies in June and July.

Included Species. A. (Rhinomegilla) megarrhina Cockerell, *orophila* Cockerell, *sichuanensis* (Wu) and *spinitarsis* Wu. *Rhinomegilla* has only been collected in the Xizang and Sichuan Provinces of China and in Sikkim. *A. megarrhina* is found in Sikkim at Khamba Jong and Gantok at altitudes of 15-16,000 feet (4572-4877 m), in Gyangtse at 13,000 feet (3962 m) and Tinki Dzong at 14,000 feet (4267 m).

Petalosternon new subgenus

Type species: *A. rivolleti* Pérez, 1895.

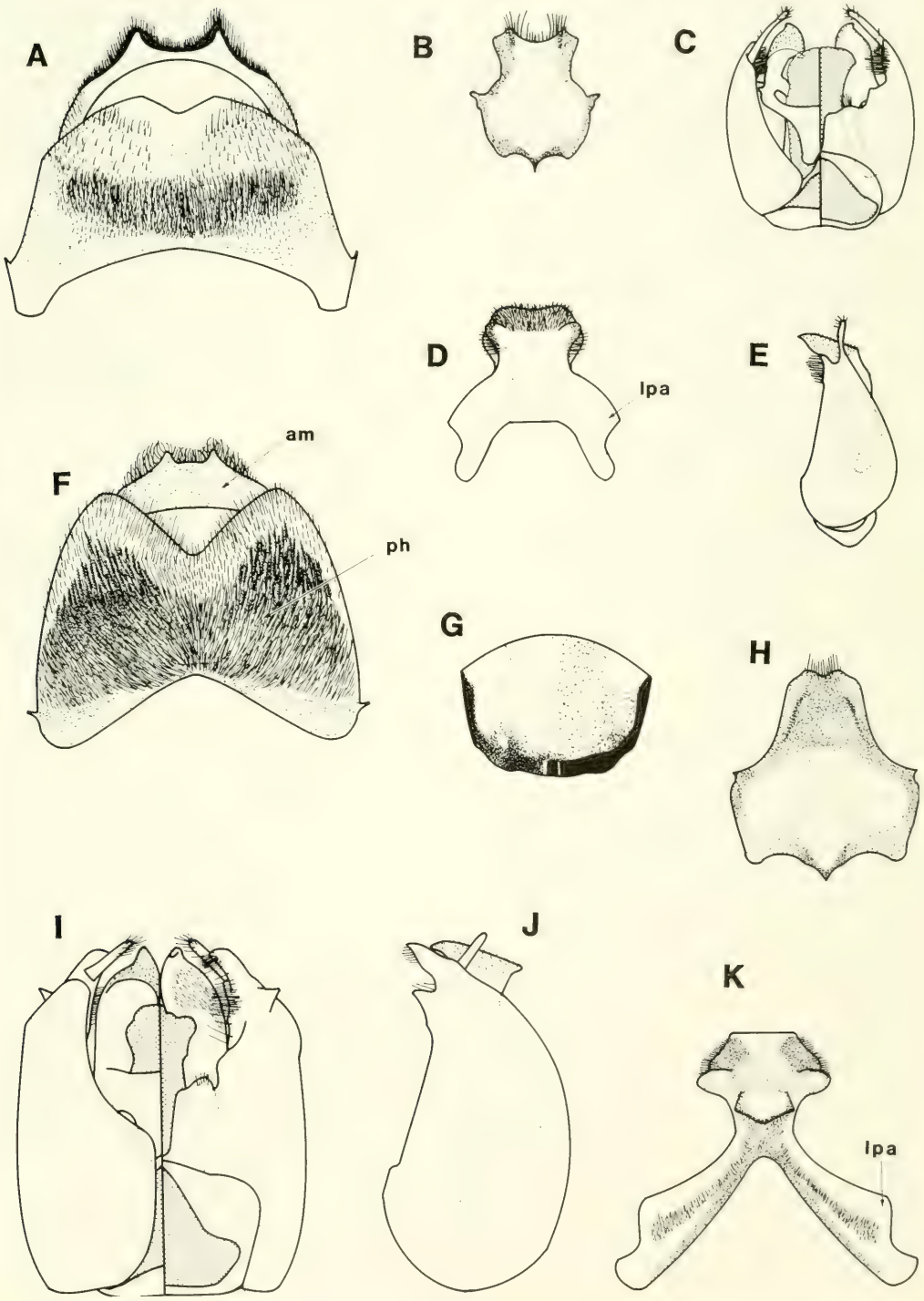
Diagnosis. Apodeme of S7 of male with lateral process (Fig. 27d); S8 of male broadly emarginate apically, apicolaterally angulate (Fig. 27b); labrum of male usually apically trilobed (Fig. 27g); pygidial plate of male absent, T7 with two submedian teeth (Fig. 27a); apex of gonocoxite of male diagnostic, in profile bilobed (Figs. 27e).

Description. a. Flagellar segment 1 of female equal to length of next 2.5-4.3 segments together; of male to next 1.7-2.7 segments. b. Face of male with yellow (except *A. albifascies* with white), of female black; labrum of male apically trilobed with emarginate median lobe (only emarginate median lobe present in *albifascies* and *orotavae;* lateral lobes weakly developed in *crassipes*) (Fig. 27g). c. Malar space of female 3.0-6.3 times as wide as long, of male 3.5-13.0 times as wide as long; flabellum apically with several finger-like lobes; mentum near basal third simple, without anterior tooth; mentum .7-.8 as long as prementum; paraglossa .7-.8 as long as stipes. d-f. Midleg brushes of male absent. g. Hind basitarsus of male simple (except *albifascies* and *hanseni* with sharp tooth); hind tibia of male normal or dilated with an anterior apical spine, tibial spur inserted on spine's apical third; hind femur of male normal or dilated, bulbous. h. Basitibial plate of male absent. i. S6 of male moderately to broadly emarginate (Fig. 27a). j. Apex of disc of S7 of male broadly, but weakly emarginate to entire (produced medially in *aeneiventris*), lateral margin medially with a weak ventral and dorsal lobe, sometimes dorsal lobe basal to ventral lobe; middle of disc simple, with one or two projections or with a longitudinal ridge; length of apodeme 1.0-1.6 times as long as length of disc (Fig. 27d). k. Apex of S8 of male weakly to deeply bilobed (produced medially in *aeneiventris*), lateral margin angulate to weakly concave; longitudinal sclerotization usually absent (Fig. 27b). l. Apex of gonocoxite of male in profile weakly bilobed ventroapically, sometimes with a tooth basal to lower lobe on inner margin of gonocoxite (Fig. 27e). m. Gonostylus of male flattened to round in cross section, 5.7- 11.0 times as long as wide, sometimes with expanded base. n. Apex of penis valve 1.4-2.7 times as long as wide viewed apicodorsally. o. Bridge of penis valve basally emarginate (entire in *hanseni* and *albifascies*), 1.9-3.1 times as long as wide (except *rivolleti* which is about as long as wide), bridge sometimes basally narrowed or expanded. p. Pygidial plate of male absent; apex of T7 of male with two submedian teeth (Fig. 27a) (no teeth, only shelf present in *hanseni*), much like *ireos* and other species of *Paramegilla,* sometimes with median, subapical longitudinal ridge; gradular process of T7 of male absent. q. First recurrent vein joining submarginal cell 2 distal to midpoint. r. Sting in repose slightly surpassing apex of gonostylus, about 2.3 times length of gonostylus. s. Length 10.0-12.5 mm.

Etymology. Petalos (Gr.), broad, flat, outspread, plus *sternon* (Gr.), referring to the wide disc of S7 of the male.

Comments. Petalosternon is closely related to *Dasymegilla* and *Clisodon.* It can be separated from *Clisodon* by the bidentate rather than tridentate mandibles, and from *Dasymegilla* males by having the part of the apical margin of T7 that is bent anteroventrad narrowed, and the much broader

FIG. 27. *Anthophora* subgenera *Petalosternon* and *Dasymegilla,* males. lpa = lateral process of apodeme, am = apex of T7, ph = felt-like pad of hair. A-E, G, *A. (P.) rivoletti* and F, H-K, *A. (D.) quadrimaculata.* A, S6, T7, ventral views. B, S8, ventral view. C, Genital capsule, dorsoventral view. D, S7, ventral view. E, Side view of genital capsule. F, S6, ventral view. G, Labrum. H, S8, ventral view. I, J, Genital capsule, dorsoventral and side views. K, S7, ventral view.


A
B
C
D
lpa
E
am
F
ph
G
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I
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K
lpa

S8 which is not nearly as narrowed medially. I know from no good characters to separate the females from *Dasymegilla*.

Biology. Adults are active from April to September.

Included Species. A. (Petalosternon) aeneiventris Hedicke, *albicilla* Pérez, *albifascies* Alfken, *calcarata* Lepeletier, *crassipes* Lepeletier, *cunicularia* Friese, *extricata* Priesner, *hanseni* Morawitz, *intricata* Gribodo, *moricei* Friese, *murina* Fedtschenko, *nigrociliata* Pérez, *orotavae* (Saunders), *priesneri* Alfken, *radoszkowskyi* Fedtschenko, *rivolleti* Pérez, *rugosa* Radoszkowszky, *similis* Fedtschenko, *wadicola* Alfken, *wegelini* Friese, and *zanoni* Gribodo. The distribution of this group is mainly Mediterranean and eastward to southwestern Mongolia.

Dasymegilla new subgenus

Type species: *Apis quadrimaculata* Panzer 1798 (=*Apis vulpina* Panzer 1798, nec Christ 1791).

Lasius Jurine, [1801-1802], p. 164. Invalidated by the suppression of the "Erlangen List" by the ICZN, Opinion 135.

Type species: *Apis quadrimaculata* Panzer 1798. Monotypic.

Diagnosis. S7 of male with long, widely separated apodemes and small disc (Fig. 27k); apex of gonocoxite of male bilobed (Figs. 27i, j); S6 with dense pad of hair on basal half (Fig. 27f); pygidial plate absent, T7 of male apically with two submedian teeth, actual apical margin bent anteroventrad, wide (Fig. 27f).

Description. a. Flagellar segment 1 of female about equal to length of next three segments together; of male to next 2.0-2.5 segments. b. Face of male creamy white to yellow, of female black; labrum of male apically trilobed as in *Petalosternon* (Fig. 27g) (weakly so in *A. lacteifrons,* simple in *muscaria, excisa* and *waltoni*), with emarginate median lobe. c. Malar space of female 4-5 times as wide as long, of male 5-7 times as wide as long; flabellum apically with several finger-like lobes; mentum near basal third simple, without anterior tooth (except *excisa*), mentum about .6 as long as prementum; paraglossa about half as long as stipes. d-f. Midleg brushes of male absent. g. Hind basitarsus of male simple. h. Basitibial plate of male absent (present in *excisa*). i. S6 of male with apical margin weakly to narrowly emarginate with thick, dense pad of hair occupying basal half of disc (Fig. 27f). j. Apex of disc of S7 of male entire to weakly emarginate, apicolateral margin with two lobes, a dark sclerotized ventral lobe and light sclerotized dorsal lobe, middle of disc with dark sclerotized transverse ridge or protuberance, length of apodeme 1.00-1.75 times as long as length of disc (Fig. 27k). k. Apex of S8 of male weakly bilobed, lateral margin on apical half concave, longitudinal sclerotization present (Fig. 27h). l. Apex of gonocoxite of male in profile bilobed (Fig. 27j). m. Gonostylus of male 6 times as long as wide (Fig. 27i). n. Apex of penis valve about twice as long as wide with scattered setae. o. Bridge of penis valve basally emarginate, 2.0-2.5 times as long as wide. p. Pygidial plate of male absent; apex of T7 of male with two acute, short, submedian teeth, actual apical margin bent anteroventrad and wide (Fig. 27f); gradular process of T7 of male absent. q. First recurrent vein joining submarginal cell 2 distal to midpoint. r. Sting in repose attaining apex of gonostylus, about 2.3 times length of gonostylus. s. Length of male, 9.0- 11.0 mm, female, 10.0-12.5 mm.

Etymology. Dasys (Gr.), densely hairy, plus *Megilla* a name of a related taxon, referring to the large, dense patch of hair on the basal half of S6 of the male.

Biology. The only species of *Dasymegilla* whose nesting biology is known is *A. quadrimaculata* (Nielsen, 1902).

Included Species. A. (Dasymegilla) excisa Morawitz, *lacteifrons* Hedicke, *muscaria* Fedtschenko, *quadrimaculata* (Panzer), *siewersi* Morawitz and *waltoni* Cockerell. They are found throughout Europe including England, Scandinavia, the Mediterranean region and eastward to central and southern China.

Subgenus *Clisodon* Patton

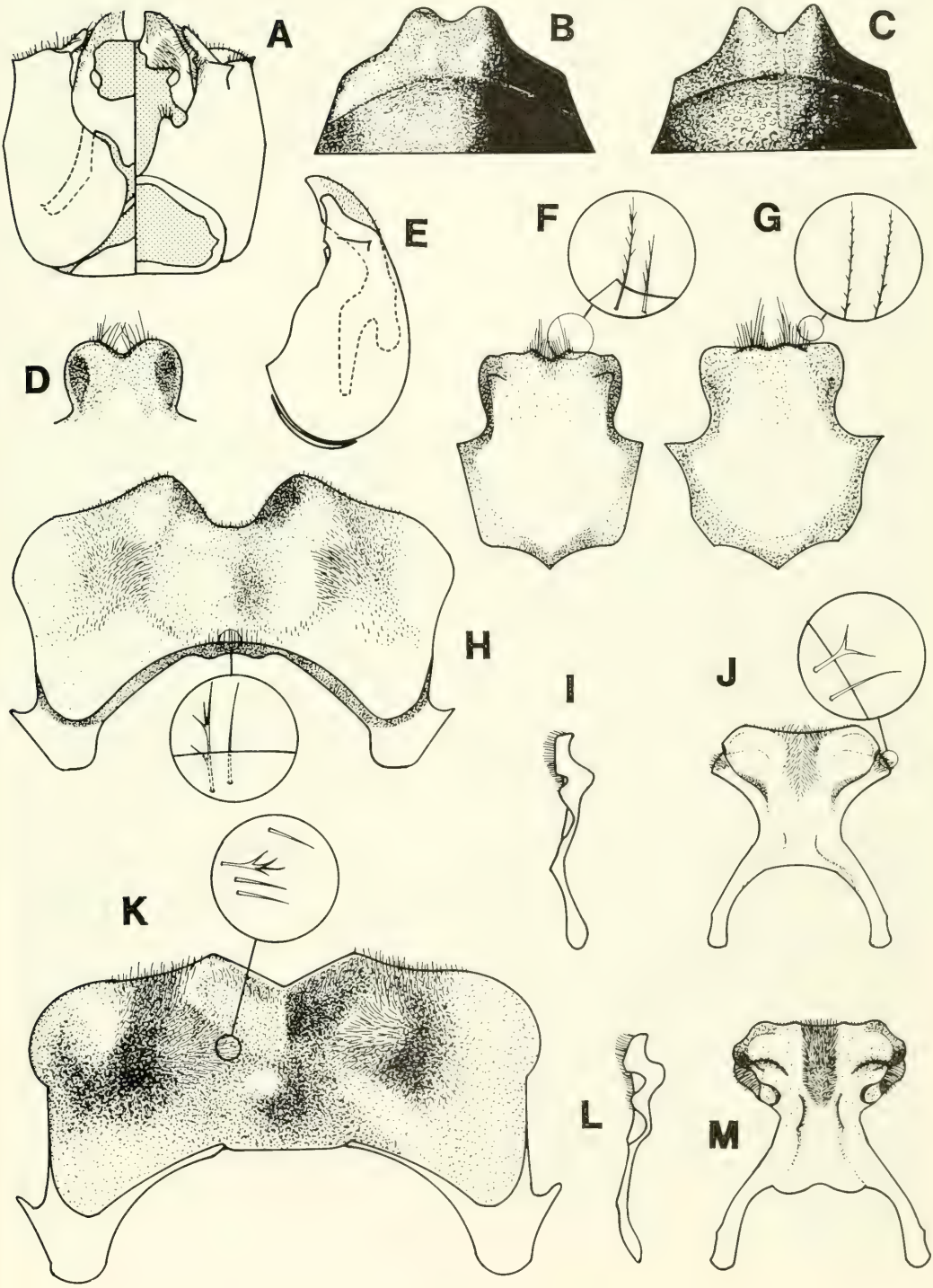
Clisodon Patton, 1879, p. 149.

Type Species: *Anthophora terminalis* Cresson, 1869. Original designation.

Diagnosis. Mandible tridentate; gonostylus of male, if present, completely sclerotized, concolorous with gonocoxite (see *Description,* character n); female with basitibial plate elongate and pointed (Fig. 29b); flabellum apically entire (Figs. 29c, d); female with hairs of posterior margin on hind tibia simple as in Figure 10e, penis valve with thick, round, patch of hair ventrally (Fig. 28a).

Description. a. Flagellar segment 1 of female equal to next 3.0 segments together, of male equal to next 2.3 segments. b. Face of male with yellow markings, of female black; mandible tridentate. c. Malar space of female about 7 times as wide as long, of male about 5.5 times as wide as long; flabellum apically entire (Figs. 29c, d); mentum

FIG. 28. *Anthophora* subgenus *Clisodon,* males. A, C, E, F, H-J, *A. (C.) furcata;* B, G, K-M, *A. (C.) terminalis.* A, Genital capsule, dorsoventral view. B, C, Apex of T7 (hair omitted), dorsal views. D, Apex of S8, ventral view, *A. (C.)* sp. from Bohemia. E, Genital capsule, side view. F, S8, ventral view, specimen from Celákovic, Czecholavakia. G, H, S8 and S6, ventral views. I, J, S7, side and ventral views. K, S6, ventral view. L, M, S7, side and ventral views.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.7 as long as prementum, mentum simple, without anterior tooth near basal third; paraglossa .7 as long as stipes. d-f. Midleg brushes of male absent. g. Hind basitarsus of male simple, flattened and curved posteriad; hind tibia of female with scopal hairs simple, lacking posterior band of plumose hairs (Figure 10e). h. Basitibial plate of male absent, of female elongate, apically pointed (Fig. 29b). i. S6 of male apicomedially emarginate, apical margin flexed ventrally, disc on anterior half with large bump on either side of a smaller, slightly more basal, median one (Figs. 28h, m). j. Disc of S7 of male broad, apex broadly but shallowly emarginate, apicolateral margin of disc with a ventral lobe and slightly basal to it a dorsal lobe, disc with lateral, basal projection and with longitudinal median band of hair (Figs. 28k-m, o), apodeme .6-.8 times as long as disc (Fig. 28l). k. S8 of male apically broad, apicolateral margin rounded to angulate, longitudinal sclerotization absent (Figs. 28i, j). l. Apex of gonocoxite of male trilobed *(A. furcata)* to bilobed *(terminalis)* in profile, with large, apical, inner lobe and two *(furcata)* or one *(terminalis)* smaller laterobasal, outer lobe (Fig. 28e). m. Gonostylus of male, if present, concolorous with apex of gonocoxite such that there is no demarcation between the two (Fig. 28a). n. Apex of penis valve 1.6 times as long as wide, covered with short hair and ventrally with a round patch of longer hair (Fig. 28a). o. Bridge of penis valve basally emarginate, 2.4 times as long as wide. p. Pygidium of male apically with 2 submedian teeth, dorsoventrally flattened, gradular process of T7 of male developed, (Figs. 28b, c). q. First recurrent vein joining submarginal cell 2 distal to midpoint. r. Sting in repose attaining apex of gonostylus, about 2.2 times as long as gonostylus. s. Length 9-13 mm.

Comments. Marikovskaya (1979), using the taxonomic analysis method of Smirnov (1969), broadened the definition of *Clisodon* and added 17 species. She recognized two groups, the first (*C.*

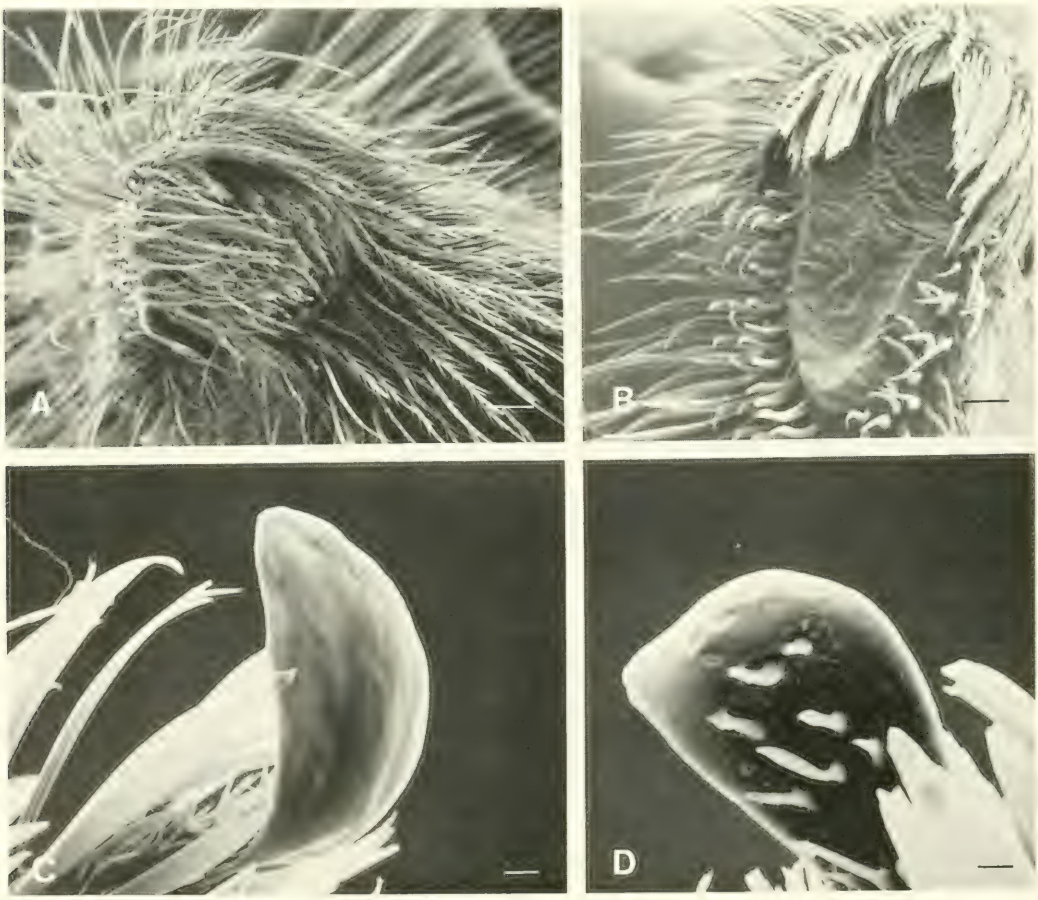


FIG. 29. *Anthophora* subgenera *Pyganthophora* and *Clisodon*. Scale lines represent .1 mm in A, B, and .01 mm in C, D. A, B, Basitibial plates of *Anthophora (Pyganthophora) edwardsii* male and *A. (Clisodon) terminalis*, female. C, D, Flabella of *A. (Clisodon) terminalis* lateroposterior and anterior views.

furcatus group) including *A. furcata* (Panzer), *terminalis* Cresson, *borealis* Morawitz, *meridionalis* Fedtschenko, *raddei* Morawitz, *pubescens* (Fabricius), *dufourii* Lepeletier, *wegelini* Friese, *rivolleti* Pérez and *urbana* Cresson and the second (*A. parietina* group) consisting of *plagiata* (Illiger) [=-*parietina* (Fabricius)], *nigripes* Morawitz, *orientalis* Morawitz, *siewersii* Morawitz, *excisa* Morawitz, *vulpina* (Panzer), *muscaria* Fedtschenko, *hortensis* Morawitz, and *gracilipes* Morawitz. Marikovskaya's broad definition and diagnosis of *Clisodon* and of her two included groups is based on characters showing much variation. In my opinion *Clisodon* (sensu Marikovskaya) is polyphyletic and represents seven distinct lineages which I place in other subgenera of *Anthophora.*

Clisodon (in its usual restricted sense) has often been accorded generic rank (Patton, 1879; Popov, 1951). Its mandibular and basitibial plate differences from other *Anthophora* are striking, no doubt associated with its wood-nesting habits. It is, however, only a small derived group of *Anthophora;* the derived features are neither so numerous or so striking as to justify generic rank (and the resulting paraphyly of *Anthophora).*

Biology. The adults are active from mid May to September. Many of the uniquely derived characters of *Clisodon,* which easily separate it from its close relatives *Dasymegilla* and *Petalosternon,* such as the tridentate mandibles and basitibial plate of the female, are presumably adaptations to wood nesting. Wood as a nesting substrate is known only for *Clisodon* in the Anthophorini [except perhaps for *A. (Anthophoroides) signata*]. Females nest in fallen logs utilizing beetle exit holes, and in rotten wood, stumps, telephone poles, fence posts, partially decayed or pithy sticks, etc. [(W. P. Cockerell, 1903, and Medler, 1964 — *terminalis*); (Nielsen, 1902; Popov, 1951; Radchenko, 1984 — *furcata*)]. Because of the preferance for a wood substrate, *Clisodon* is usually a forest dweller. I have observed the dark form (*pernigra* Cresson of *terminalis*) nesting in driftwood among sand dunes on Mad River Beach in Humboldt County, California. The females, which are somewhat polylectic, have a definite preference for plants of the family Lamiaceae, especially *Stachys* (Popov, 1951).

Included Species. A. (Clisodon) furcata (Panzer), *sinensis* (Wu), *terminalis* Cresson and *xinjiangensis* (Wu). *Clisodon* is a boreal holarctic group which ranges far into the Arctic both in North America and the U.S.S.R. Popov (1951) found that the distribution of *terminalis* besides being nearctic, included East to Central Asia and that of *furcata* was mainly European to the Near and Middle East. In the United States *terminalis* is generally found wherever there are northern woodlands, i.e., in the northern states and in the mountains southward.

Subgenus *Heliophila* Klug

Heliophila Klug, 1807, p. 227.
Type species: *Apis bimaculata* Panzer, 1798. Monobasic.

Saropoda Latreille, 1809, p. 177.
Type species: *Apis bimaculata* Panzer, 1798. Autobasic. Proposed unnecessarily for *Heliophila* Klug, 1807, not *Heliophilus* Meigen, 1803.

Micranthophora Cockerell, 1906, p. 66. **New Synonym.**
Type species: *Anthophora curta* Provancher, 1895 (=*A. squammulosa* Dours, 1869). Original designation.

Diagnosis. Length 6.0-15.0 mm, usually 10 mm or less in almost all species of Humilis and Estebana species groups; female face with pale markings, rarely all black as in *A. praecox;* posterior margin of female hind tibia with simple hair (Fig. 10d); male of Old World species usually with S6 and often S5 with thick pad of hair in a depression (Figs. 30a, 31e), pad covering much of preapical ventral surface.

Description. a. Flagellar segment 1 of female equal to length of next 2.0-3.5 segments together; of male equal to next 1.1-2.8 segments. b. Face with white to yellow markings, rarely black; male with paraocular and supraclypeal marks present or absent, labrum of male usually apically trilobed with median lobe emarginate (as in Fig. 30l); scape of male with pale marks anteriorly; female clypeus usually bearing inverted T-shaped mark, paraocular marks of female present or absent, supraclypeal mark of female present or absent; maxillary palpus 4-6 segmented; labial palpus 2 or 4 segmented (apical 2 segments sometimes lost). c. Malar space of female 5-16 times as wide as long, of male 6-16 times as wide as long; flabellum apically with several finger-like lobes; mentum without anterior tooth on basal third, mentum .6-.7 as long as prementum (except .3 in *A. hololeuca*); paraglossa about .50-.75 as long as stipes. d-e. Midtarsal and midbasitarsal brushes of male absent. f. Middistitarsal brush of male sometimes present. g. Hind basitarsus of male simple (except *flexipes* with anterior tooth), sometimes flattened and/or strongly curved; hind tibia of male sometimes with apical, anterior spine; posterior margin of hind tibia of female with simple hair (Fig. 10d). h. Basitibial plate of male usually present. i. S6 of male usually apicomedially emarginate (Fig. 30a), in Old World species usually with dense pad of hair covering much of basal half of ventral surface, basally delimited by gradulus (Figs. 10f, 30a), pad occupying large, flat depression; in Old World species S5 often with similar pad of hair and depression, often deeply emarginate apically. j. S7 of male (Fig. 30e) not or slightly expanded apically, emarginate to produced medially with apex gently rounded; lateral margin with two

lobes to simple; length of apodeme .28-.75 length of disc [except 1.16 length of disc (Fig. 30e) in *bimaculata*]. k. S8 of male apically emarginate, occasionally emargination weak to absent; apicolateral margins either angulate or rounded, longitudinal sclerotization present to absent (Fig. 30d). l. Apex of gonocoxite of male flattened, in side view usually bilobed to trilobed (Fig. 30c), occasionally simple. m. Gonostylus of male short, from dorsal view flattened, 2.2-8.5 as long as wide. n. Apex of penis valve 1.3-3.0 as long as wide viewed apicodorsally. o. Bridge of penis valves usually not basally expanded, 1.0-2.5 as long as wide and basally entire to emarginate. p. T7 of male with two apical teeth (pygidial plate in *fraterna* and *squammulosa*), additionally two or more subapical teeth occasionally present in Ethiopian species; gradular process of T7 of male usually well developed, sometimes prolonged into tooth (Fig. 30f); female pygidial plate with or without median ridge. First recurrent vein joining submarginal cell 2 distal to midpoint. q. First

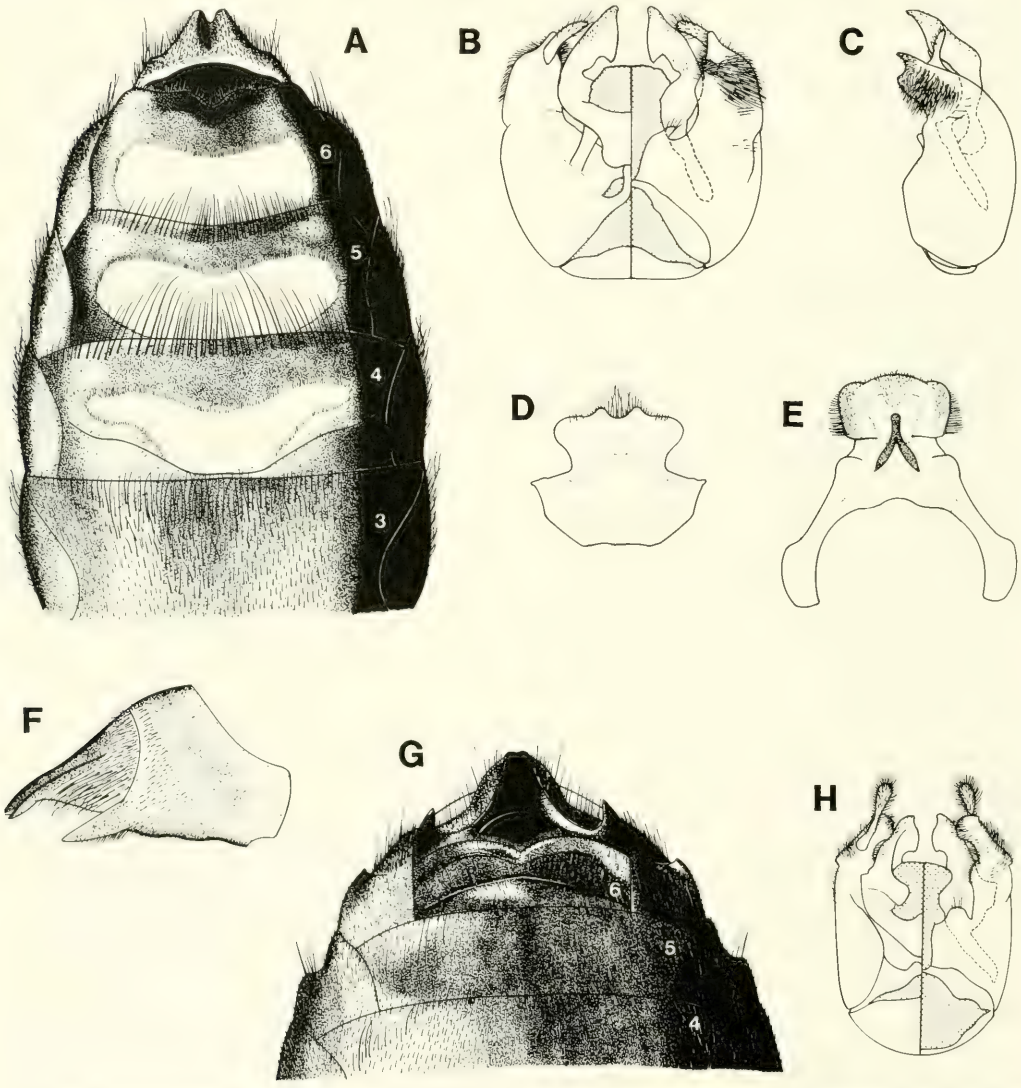


FIG. 30. *Anthophora* subgenus *Heliophila,* males of Humilis and Estebana species groups. Numbers are the numbers of the metasomal sterna. A-E, *A. (H.) bimaculata;* F-L, *A. (H.) squammulosa.* A, S3-S6, T7, ventral views. B, C, Genital capsule, dorsoventral and side views. D, E, S8 and S7, ventral views. F, T7, side view. G, S4-S6, T7, ventral views. H, I, Genital capsule, dorsoventral and side views. J, K, S7 and S8, ventral views. L, Labrum.

recurrent vein joining submarginal cell 2 distal to midpoint. r. Sting in repose attaining to surpassing apex of gonostylus, about 2.2-2.7 times as long as gonostylus. s. Length 6.0-15.0 mm.

Comments. An attractive idea is to separate *Heliophila* as a genus from *Anthophora.* I long considered this possibility, which could be justified on the basis of small size and somewhat dissimilar male terminalia. However, the Vestita species group bridges the gap between the two so that recognition of *Heliophila* as a genus would be highly arbitrary as well as making *Anthophora* paraphyletic.

Humilis Species Group

Description. a. Flagellar segment 1 of female equal to length of next 2.0-3.0 segments together; of male equal to next 1.1-2.0 segments. b. Face with white to yellow markings; male with paraocular and supraclypeal marks present, labrum of male usually apically trilobed with median lobe emarginate (as in Fig. 30l); scape of male with pale marks anteriorly; female clypeus bearing inverted T-shaped mark, rarely all pale (ascending median arm of mark almost never absent or indistinct as in an undescribed species from Cape Province, South Africa), paraocular marks almost always absent (except in an undescribed species from Kenya and Tanzania), supraclypeal mark present; maxillary palpus 4-6 segmented; labial palpus 2 or 4 segmented (apical 2 segments sometimes lost). c. Malar space of female 5-13 times as wide as long, of male 6-16 times as wide as long; paraglossa about .5 as long as stipes. f. Middistitarsal brush of male sometimes present. g. Hind basitarsus of male simple, sometimes flattened and/or strongly curved; hind tibia of male sometimes with apical, anterior spine. h. Basitibial plate of male usually present. i. S6 of male usually apicomedially emarginate (Fig. 30a), but some southern and southeastern African species with apex entire (e.g., some *rufovestita* and *tetradonta*); usually with dense pad of hair covering much of basal half of ventral surface, basally delimited by gradulus (Figs. 10f, 30a), pad occupying large, flat depression (pad absent in some African species); S5 often with similar pad of hair and depression, often deeply emarginate apically. j. S7 of male (Fig. 30e) not or slightly expanded apically, entire medially (rarely emarginate and then only slightly) with apex gently rounded; lateral margin with two lobes, ventral more apical lobe larger and usually more darkly sclerotized than dorsal one; disc sometimes with lateral margins lobed midway (as in some African species) but usually margins gradually converging toward apex, length of apodeme .32-.61 length of disc [1.16 length of disc (Fig. 30e) in *bimaculata*]. k. S8 of male apically emarginate, occasionally emargination weak; apicolateral margins either angulate or rounded, longitudinal sclerotization usually present (Fig. 30d). l. Apex of gonocoxite of male flattened, in side view bilobed to trilobed (Fig. 30c), in ventral or dorsal views apicolateral margin either angulate or rounded, apex not projecting inward but extending somewhat straight distally (Fig. 30b). m. Gonostylus of male short, from dorsal view flattened, 3.0-6.0 as long as wide. n. Apex of penis valve 1.3-2.6 as long as wide viewed apicodorsally. o. Bridge of penis valves not basally expanded, either 1.0-1.5 as long as wide and basally entire, or bridge 2.0-2.5 times as long as wide and sometimes emarginate basally (Fig. 30b). p. Pygidial plate of male present, apically emarginate, sometimes like that of *Lophanthophora* (e.g., *fraterna*), or with a short tooth situated laterobasally on margin of pygidial plate (e.g., *rufovestita*), or deeply emarginate (Fig. 10f) (e.g., *fulvodimidiata*), more often with strong median ridge; gradular process of T7 of male usually well developed, sometimes prolonged into a tooth (Fig. 30f); female pygidial plate almost always flat, without median ridge [an undescribed species from Peshin Jan (Farah) India has a well developed ridge]. q. First recurrent vein joining submarginal cell 2 distal to midpoint. r. Sting in repose attaining apex of gonostylus, about 2.4 times as long as gonostylus. s. Length 7.5-11.5 mm.

Comments. A. bimaculata is typical of a small species group within the Humilis group, not formally recognized here, having distinctly different terminal sterna. The S7 of male *bimaculata* has long apodemes and S8 is narrower apically and more deeply emarginate than subsaharan species (Figs. 30d, e). The rest of the species of the Humilis group (mainly African) have S7 with short apodemes and S8 apically broad with lateral margins weakly emarginate.

The Humilis species group is a group with transitional characters between the Estebana (= *Micranthophora*) and the Vestita species groups, although it is most closely related to the latter from which it differs by its small size, more extensive pale markings on the faces of females, lack of the two median projections on the female labrum, apicolateral margins of the genital capsule more or less straight and S8 of the male with lateral margin deeply emarginate. The Humilis group is similar to the Estebana group, being differentiated usually by the synapomorphies (shared with the Vestita group) of the dense pads of hair on S6 and S5 in males, lateral margin of S7 of male weakly bilobed (ventral as well as dorsal lobe present), S8 of male with apicolateral margins produced (not with apex produced as in the Estebana group), longitudinal sclerotization of S8 usually present and pygidial plate of female usually flat (see character p).

Biology. The adults are active from March to November in the Palearctic region and November to August in subsaharan Africa.

Included Species. A. (Heliophila) albella Gussakovsky, *albifronella* Brooks, *albopicta* Cockerell, *alfkenella* Priesner, *appletoni* Cockerell, *bimaculata*

(Panzer), *candidifrons* Cockerell, *concinna* (Klug), *deceptrix* Priesner, *elbana* Priesner, *eugeniae* Gussakovsky, *fallaciosa* Priesner, *fayoumensis* Priesner, *ferripicta* Cockerell, *flavofimbriata* Hedicke, *fulvodimidiata* Dours, *fraterna* Bingham, *galalensis* Priesner, *gemella* Morawitz, *hegasica* Priesner, *humilis* (Spinola), *loewi* Fedtschenko, *longipes* Morawitz, *mellina* Priesner, *nigripes* Pérez, *perlustrata* Priesner, *pygmaea* Meade-Waldo, *richaensis* Alfken, *rufovestita* Cockerell, *saropodoides* (Dalla Torre), *selecta* Priesner, *shagrensis* Priesner, *soikai* Benoist, *tarsalis* Priesner, *tenella* (Klug), *tetradonta* Cockerell, *tibialis* Morawitz, *tridentata* (Friese), *tridentella* Priesner, *trilineata* (Pérez), and *xanthostoma* Cockerell. This group is found in the savanna regions of Africa but reaches the Mediterranean region and southern Europe, thence eastward to Xizang Province (Tibet), China.

Vestita Species Group

Description. a. Flagellar segment 1 of female equal to length of next 2.7-3.3 segments together; of male equal to next 1.3-2.8 segments. b. Face with white to yellow markings, rarely all black; female usually with pale transverse mark across apex of clypeus, rarely in form of inverted T (*A. oldi* and *micheneri* have an inverted T-shaped mark), rarely all black (e.g., *praecox*); paraocular and supraclypeal marks in female usually absent, in male usually present (except species with all black faces e.g., *praecox*); maxillary palpus usually with 6 segments, sometimes 5; labrum of female almost always with two median projections, their widths .2-.5 labral width, one situated midway, the other apical; apical projection of female labrum bilobed, middle projection of female labrum often shelf-like, apically entire to bilobed (Fig. 32a) (projections reduced in *praecox,* absent in *micheneri*); labrum of male apically trilobed (except *pulverosa,* medioapically bilobed) with median lobe emarginate, projection in middle of labrum as in female when present, but usually absent; scape of male with pale marks anteriorly (except those with all black faces). c. Malar space of female 6-13 times as wide as long, of male 8-12 times; paraglossa .50-.75 length of stipes. f. Middistitarsal brush of male usually present. g. Hind basitarsus of male simple. h. Basitibial plate of male usually present (absent in *vestita* and *pulverosa*). i. S6 of male entire to shallowly emarginate apically, basal half to two-thirds of disc with dense pad of hair as in males of Humilis group (Fig. 32b) (absent in *pulverosa*); S5 of male with similar pad of hair, apically emarginate (*pulverosa* without pad of hair and apically entire); S4 of male occasionally with similar pad of hair, pads of hair on metasomal sterna 6-5 (and 4 when pad present) each recessed into a depression. j. S7 of male as in males of Humilis group except dorsal pair of apicolateral lobes sometimes absent, length of apodeme .28-.43 length of disc (Fig. 32e). k. S8 of male mediobasally blunt, rounded, apically broad, apicolateral margin angulate, longitudinal sclerotization present (Fig. 32f). l. Apex of gonocoxite of male strongly produced laterally as viewed from beneath, inner margin somewhat straight (Fig. 32c). m. Gonostylus of male 3.7-6.3 times as long as wide, flattened (Fig. 32c). n. Apex of penis valve 1.5-2.7 times as long as wide viewed apicodorsally. o. Bridge of penis valves basally emarginate, sometimes expanded basally, length 1.6-2.5 times as long as wide. p. T7 of male dorsally deeply concave, forming round pit with 2 submedian teeth extending from apical shelf or more deeply emarginate without shelf-like area and dorsal concavity; median longitudinal ridge of T7 absent; gradular process of T7 developed, sometimes prolonged into a spine; pygidial plate of female flat. q. Venation like that of Humilis group. r. Sting in repose surpassing apex of gonostylus as much as .4 length of gonostylus; sting 2.4-2.7 as long as gonostylus. s. Length 10-15 mm.

Comments. Some species have males with all black faces, a character which is not found in the Humilis and Estebana groups, but is found occasionally among other species of *Anthophora.* The moderate size of the bees and the relatively limited pale marks of the female face are characters of the Vestita group shared with other subgenera of *Anthophora* and not with the Humilis group. The Vestita group has more plesiomorphies than the Humilis and Estebana groups.

Biology. The adults fly from October to August. Rozen (1969) gave some biological notes on *A. braunsiana* and *rufolanata* (determined as *krebsi*) which were attacked by the cuckoo bees *Thyreus* and *Coelioxys* respectively.

Included Species. A. (Heliophila) argyrospila Cockerell, *braunsiana* Friese, *ekuivensis* Cockerell, *elimata* Cockerell, *eritrea* Brooks, *joetta* n. sp., *kigomensis* Cockerell, *kigoserana* Friese, *kodrokonis* Cockerell, *kristenseni* Friese, *labrosa* Friese, *lumbwana* Cockerell, *matopensis* Cockerell, *micheneri* n. sp., *oldi* Meade-Waldo, *perdita* Cockerell, *praecox* Friese, *pulverosa* Smith, *rhodesiae* Meade-Waldo, *rufolanata* Dours, *tuberculilabris* Dours, *vestita* Smith, *wartmanni* Friese, and *zombana* Cockerell. The Vestita group is confined to subsaharan Africa and has its greatest species diversity from Kenya to South Africa.

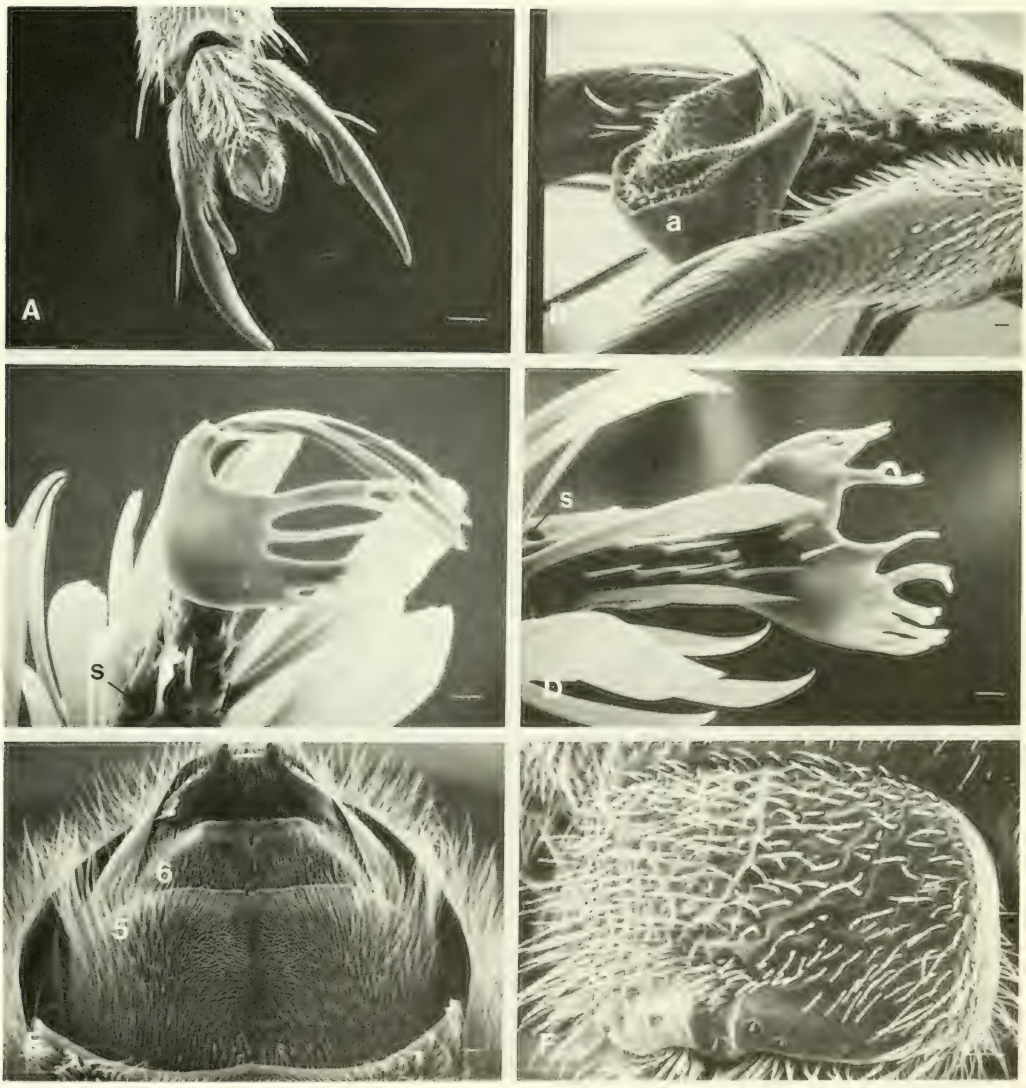


FIG. 31. *Anthophora (Heliophila) bimaculata.* Scale lines (on right side) represent .1 mm in A, E, F, .01 mm in B-D; a = arolium, s = seta. A, B, Hind tarsus of female. C, D, Lateroposterior and anterior views of flabellum. E, Ventral view of male metasoma showing the dense pad of hair on S5 and only the apex of the pad of hair on S6. F, Clypeus of male showing rugose-lacunose sculpturing and apicomedian emargination.

Estebana Species Group (=*Micranthophora*)

Description. a. Flagellar segment 1 of female equal to next 2.2-3.5 segments together, of male equal to next 1.0-2.5 segments. b. Face with white to yellow markings; mandible bidentate (simple in *A. phenax* male); paraocular marks of male usually absent (except in *cockerelli* and *phenax*), supraclypeal mark sometimes present, clypeus usually without inverted T-shaped mark (*flexipes* and *nigritula* with inverted T-shaped mark, *phenax* and *cockerelli* clypeus all pale) but with transverse mark across apex, labrum of male apically trilobed with median lobe emarginate (Fig. 30l) (except *columbariae* simple, weakly trilobed in *abroniae* and *phenax*), scape of male black or with pale marks anteriorly; female with paraocular marks usually absent (except *cockerelli* and *mortuaria*), supraclypeal marks usually present (except *squammulosa, estebana, phenax,* and *salazariae*), clypeus with a transverse mark across apex to a well developed inverted T-shaped mark (clypeus all pale in *cockerelli*); maxillary palpus almost always with 6 segments (*salazariae* with 5, *phenax* with 4). c. Malar space of female 5-16 times as wide as long, of male 6-15 times; paraglossa .50-.75 as long as stipes. g. Hind basitarsus of male simple (flattened, laterally expanded and with anterior tooth in *flexipes*). h. Basitibial plate of male present or absent. i. S6 of male emarginate apicomedially (Fig. 30g) (except *petrophila* entire, *flavocincta* entire with a pair of lateral depressions, *exigua* apicomedially produced), pad of dense hair absent. j. S7 of male apically expanded, emarginate to produced medially, with a lateral light sclerotized mark on each side, lateral margin without ventral and dorsal lobes, apodeme 0.30-.75 as long as disc (Fig. 30j). k. Apex of male S8 narrowly produced, often emarginate; lateral margin lobed midway or distad of middle,, usually strongly angulate (Fig. 30k), but in a few species weakly rounded, longitudinal sclerotization absent. l. Apex of gonocoxite of male flattened, in side view weakly bilobed to trilobed (Fig. 30i), projecting inward, apicolateral margins not produced, subparallel (Fig. 30h). m. Gonostylus of male 2.2- 8.5 times as long as wide (in *squammulosa* and *peritomae,* 10.0 times), usually flattened, seldom round in cross section. n. Apex of penis valve 2.2-3.0 times as long as wide viewed apicodorsally. o. Bridge of penis valves about as wide as long, entire and not enlarged basally. p. Pygidial plate of male absent (present only in *squammulosa,* similar to that of male *Lophanthophora*); longitudinal, median, narrowly carinate ridge absent (present in *abroniae, columbariae, mortuaria, pachyodonta, salazariae, squammulosa,* and one undescribed species); pygidial process of T7 of male present as two apical, submedian, dorsoventrally flattened projections (absent in *squammulosa*); gradular process of T7 of male often present (absent in *abroniae, columbariae, nigritula, phenax,* and *salazariae*), sometimes only weakly developed (as in *cockerelli, mortuaria,* and *pachyodonta*) or present as a tooth; pygidial plate of female with median, longitudinal ridge somewhat flattened to strongly carinate, sometimes lateral margins also carinate. q. Venation as in Humilis group. r. Sting in repose attaining apex of gonostylus, 2.2-2.4 times as long as gonostylus. s. Length 8-13.5 mm.

Comments. The Estebana Group is restricted to the New World and is closely related to the Old World Humilis group from which it is separated by the characters given in the *Comments* under the latter.

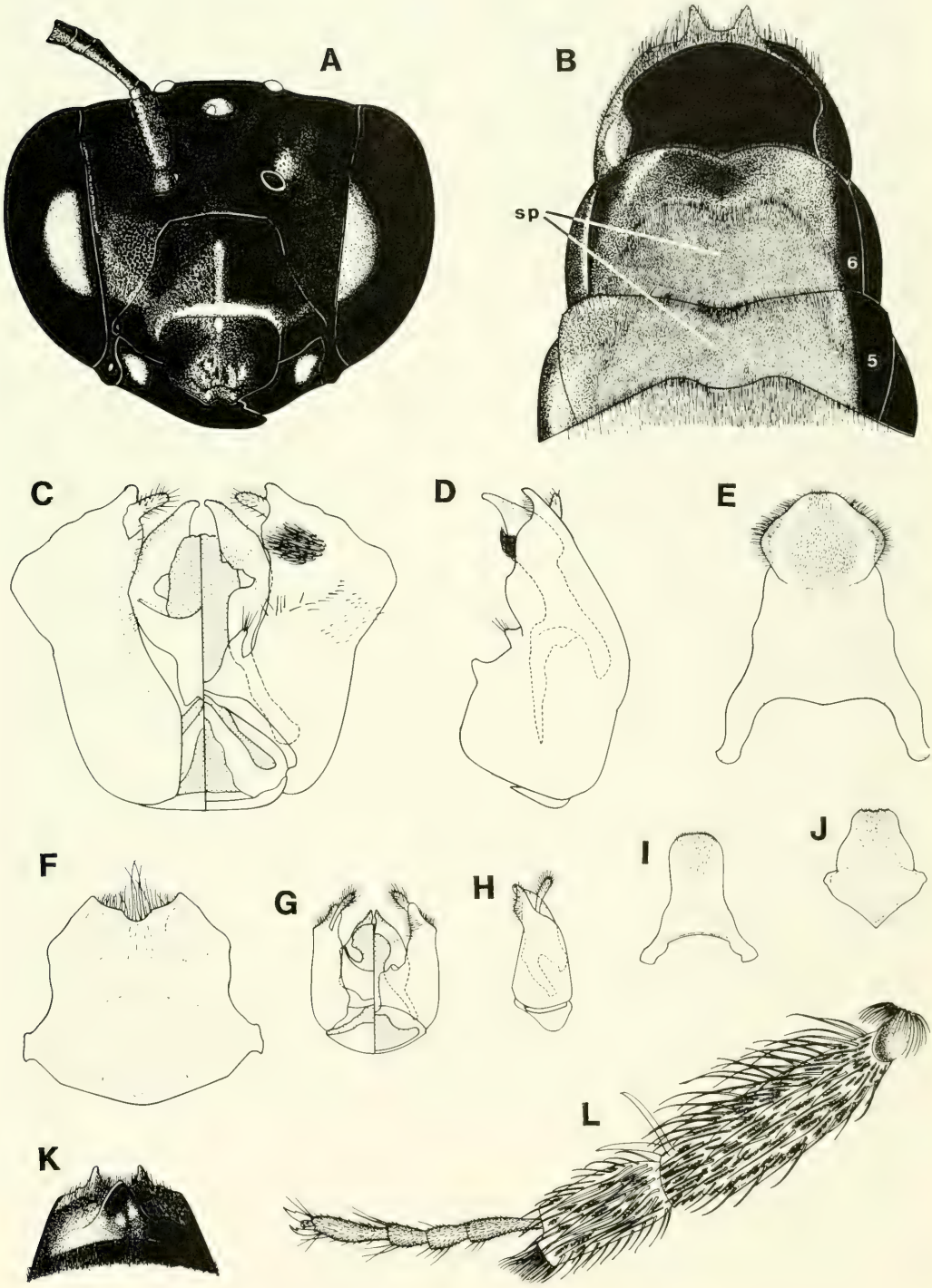
A. hololeuca, an unusual species, is found in California, Arizona and México (Baja California and Sonora) and is the smallest bee in the tribe Anthophorini. It differs from all other members of the Estebana group by the following characters: length 6-8 mm; scape of both sexes black and anteriorly with a thick patch of white hair similar in appearance to pale integumental markings; mentum .3 length of prementum; lorum V-shaped; labial palpus with two short segments (apical two lost); stipes and prementum with longitudinal rugae; hind tibia of female on outer surface with appressed white pubescence between long, simple scopal hairs (Fig. 32l). The short lorum and mentum, loss of two segments each from the maxillary and labial palpi, and rugose prementum and stipes may be adaptations to the types of host plants visited for nectar and pollen. Its short mouthparts are presumably adapted to small shallow flowers.

A. flexipes is an extremely derived species, unique in several male attributes, not the least being the elongate and oddly modified fore and midlegs and the gradular process on T6 which is prolonged into a tooth similar to that of T7.

Biology. Adults are active from February to November. The only biological accounts of species of the Estebana group is by Torchio and Youssef (1968) for *A. flexipes* and Torchio (1971) for *peritomae.* Generally the bees are polylectic but there is a definite preference for the Asteraceae. The males appear to be territorial, defending their territories from conspecific males and other similar-sized bees. The females nest in aggregations usually in earthen banks.

Included Species. A. (Heliophila) abroniae Timberlake, *albata* Cresson, *arthuri* Cockerell, *bispinosa*

FIG. 32. *Anthophora* subgenus *Heliophila,* Vestita and Estebana species groups. A-F, *A. (H.) vestita,* all male except A; G-L, *A. (H.) hololeuca,* all male except L. Numbers are the numbers of the metasomal sterna. A, Head (hair omitted). B, S4-S6, T7, ventral views. C, D, Genital capsule, dorsoventral and side views. E, F, S7 and S8, ventral views. G, H, Genital capsule, dorsoventral and side views. I, J, S7-S8, ventral views. K, T7, dorsal view. L, Hind leg, outer view.


A
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Cockerell, *cockerelli* Timberlake, *columbariae* Timberlake & Cockerell, *erythrothorax* Michener, *estebana* Cockerell, *exigua* Cresson, *flavocincta* Huard, *flexipes* Cresson, *franciscana* Cockerell, *hololeuca* Cockerell, *maculifrons* Cresson, *mortuaria* Timberlake, *nigritula* Cockerell, *pachyodonta* Cockerell, *peritomae* Cockerell, *petrophila* Cockerell, *phenax* (Cockerell), *rhodothorax* Michener, *salazariae* Timberlake, *squammulosa* Dours, *usticauda* Cockerell, *xanthochlora* Cockerell, and *zamoranella* Cockerell. Species in the Estebana group are found in xeric areas of Kansas, Oklahoma and Texas westward to California (including Wyoming), southward to Honduras. A single disjunct record of *A. squammulosa* from Guayaquil, Ecuador, is based on a specimen in the Berlin Museum; the specimen may be mislabeled.

ANTHOPHORA INCERTAE SEDIS

The following species cannot be placed with certainty as to subgenus because the holotypes are females and/or extremely worn specimens, or the types are lost, have been destroyed or not as of yet studied: *A. abjuncta* Cockerell, *acutilabris* Morawitz, *aschabadensis* Radoszkowsky, *bisulca* Pérez, *croceitarsis* Gussakovsky, *dentilabris* Morawitz, *desertorum* Gussakovsky, *doursiana* (Friese), *eversa* Cockerell, *ferghanensis* Gussakovsky, *fixseni* Morawitz, *freimuthi* Fedtschenko, *heliopolitensis* Pérez, *hortensis* Morawitz, *kazabi* Banaszak, *kronebergi* Fedtschenko, *loczyi* Morawitz, *mongolica* Morawitz, *neavei* Vachal, *niveifacies* Hedicke, *nurrana* Cockerell, *occulta* Hedicke, *petersenii* Morawitz, *postica* Vachal, *proxima* Morawitz, *robbi* Cockerell, *sefrensis* Cockerell, *shestakovi* Gussakovsky, *subaequa* Kohl, *submicans* Gussakovsky, *subsericornis* Morawitz, *thomsoni* Saunders, *trichopus* Hedicke, *trifasciata* Radoszkowsky, *usbekistana* Cockerell and *zimini* Cockerell.

Genus *Amegilla* Friese

Diagnosis. Arolia absent (Fig. 9c); hind and midlegs of male simple; hair sometimes metallic, metasoma generally with appressed pubescence (Figs. 33c, e); outer hind tibial spur much isolated from inner tibial spur (Figs. 6a-d); mentum with single anterior tooth near basal third similar to Figure 22k; galea with anterior and posterior lumens (Fig. 5a).

Description. a. Body length 8-24 mm. b. Flagellar segment 1 of female equal to combined lengths of next 2.3-4.2 flagellomeres; of male to next 1.1-2.6 flagellomeres. c. Face of male and female with yellow to white or reddish-yellow to brown integumental markings, rarely all black; clypeus flattened to protuberant, generally .33-.50 width of eye in profile but reaching greatest protrusion in *Glossamegilla* (up to .83); labrum of male apically simple; mentum with anterior tooth on basal third as in Figure 22k (except in *A. nonconforma*), mentum .60-.85 as long as prementum; paraglossa 0.67-1.20 as long as stipes; galea with posterior and anterior lumen chambers (Fig. 5a); flabellum with apical finger-like lobes (Figs. 8e, f). d-f. Midleg with brushes of male absent. g. Hind basitarsus of male simple; hind tibia of female with simple scopal hairs except posterior margin plumose (Fig. 10b). h. Apodeme of S7 .24-.67 length of disc. i. Apex of gonocoxite of male relatively simple, rotund to dorsoventrally flattened, simple to trilobed as viewed ventrally, and expanded to narrowed apically. j. Gonostylus of male often greatly reduced to only a blister, sometimes completely absent (*Notomegilla, Dizonamegilla, Micramegilla, Glossamegilla,* and almost all *Amegilla* s. str. and *Ackmonopsis,* but rarely absent in *Zebramegilla*); when present 1-10 times as long as wide. k. Penis valve apex as viewed apicodorsally 1.4-2.7 times as long as wide, setae small and scattered on surface. l. Bridge of penis valves basally entire to emarginate, apically rounded, never acute, length 0.6-2.8 as long as width. m. Pygidial plate of male absent; T7 of male medioapically with two to three teeth, sometimes shelf-like at base of teeth or basal third to two-thirds thickened dorsoventrally, median longitudinal ridge sometimes present; pygidial plate of female without median longitudinal ridge.

Distribution. Amegilla is found on all Old World continents, Madagascar, the Indomalaysian area and Australia. *Amegilla* is especially speciose in eastern Africa, the Mediterranean region and the Australasian region.

Comments. Many species of *Amegilla,* unlike *Anthophora,* are brightly colored in metallic hues of blue, green and orange hair. These hairs are appressed to the integument, flattened, with apically converging ridges (Figs. 33c-f, 34a, b). The ridges on the hairs presumably diffract the light, producing the color. Pale hair is plumose either in two opposite rows (i.e. feather-like) (Figs. 34e, f), catkin-like (i.e. all around the axis) (Figs. 34c, d) or is simple (Figs. 33a, b).

One remarkable character of female *Amegilla* found by Cane (1979) involves the partial (Figs. 6c, d) to complete (Figs. 6a, b) isolation of the outer hind tibial spur from the corium and inner hind tibial spur (Fig. 6a). A correction of Cane's (1979) Table 1 is that *Amegilla bombiformis* does not have an exoskeletal bridge, only a well developed exoskeletal process (Fig. 6d).

History. The name *Amegilla* was adopted for two North American species with white integumental bands on the metasomal terga by Robertson (1905). Attention was first called to this error by Timberlake (1951) and later by Michener (1960).

Popov (1950) placed many species in *Amegilla* that had previously been included in *Anthophora* though not all belonged there, some being true *Anthophora.* Lieftinck (1944, 1956) gave keys to Malaysian *Amegilla* (he included them in *Anthophora* in 1944) with several new species and redescriptions included. Lieftinck (1975) gave a good redescription using a broad definition of *Amegilla* and further described *Zonamegilla.* Catalogs or simply lists of *Amegilla* species (originally described in *Anthophora*) have been made for species inhabiting India (Cockerell, 1911, a partial key given), the Indian Ocean islands [Cock-

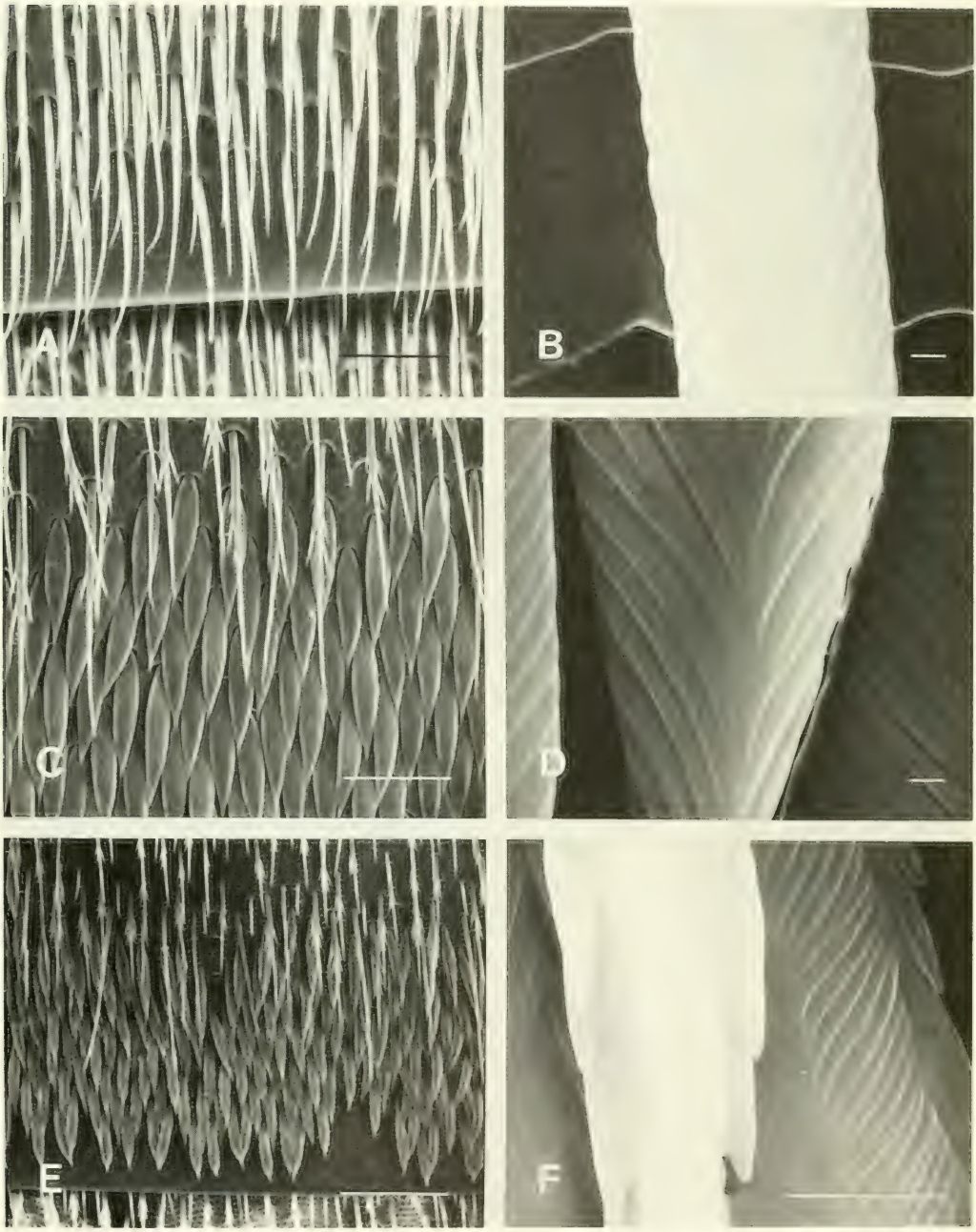


FIG. 33. Metasomal tergal hairs of *Amegilla,* dorsal view. Scale lines represent .1 mm in A, C, E, and .001 mm in B, D, F. A, B, *A. (Glossamegilla) subinsularis* showing simple red hairs (in life) and a close up of a single hair. C, D, *A. (Zonamegilla) cingulifera,* showing the flattened metallic blue-green hair (in the lower three-fourths) on apical margin of tergum and the sparsely plumose black to pale hairs (in life) (in upper one-fourth) and a close up of a flattened hair showing oblique ridges. E, F, *A. (Zebramegilla) quadrata* showing the flattened white hair (middle) and the sparsely plumose hair (top and bottom margins) and a close up of a flattened hair showing the ridges and marginal teeth.

erell, 1912; Saussure, 1890 (Madagascar only)], Australia (Cockerell, 1929, 1931b; Michener, 1965), New Guinea (Friese, 1909) and the Canary Islands (with true *Anthophora*) (Lieftinck, 1958).

KEY TO SUBGENERA OF *AMEGILLA*

1. Seven exposed metasomal terga; thirteen antennal segments, (males). . . 2
— Six exposed metasomal terga; twelve antennal segments, (females) 12
2. Apex of S8 narrowed, either bilobed or rounded such that sternum appears triangular from ventral or dorsal aspect (Figs. 35c, i, k) 3
— Apex of S8 wide, apicomedially emarginate or entire, sometimes apicomedially produced, sternum appearing rectangular from ventral or dorsal aspect (Figs. 36c, e, l) 8
3. Apex of S8 rounded or very weakly bilobed (Figs. 35i, 38c); gonostylus almost always absent, if present then body length at least 12 mm and gonostylus reduced to a blister on gonocoxite 4
— Apex of S8 strongly bilobed (Figs. 35c, k, 37c, 39c); gonostylus present (absent only in the Ethiopian *A. langi* and Indian *niveocincta* whose body lengths are 8-9 mm) as a blister to an elongate appendage 5
4. Apex of S7 only moderately expanded, appearing quadrate, apodeme without lateral tooth (Fig.35h); base of S8 simple, apically pointed (Fig. 35i); Ethiopian, Palearctic and Oriental group . . . . . *Amegilla* s. str.
— Apex of S7 strongly expanded, appearing triangular, apodeme with lateral tooth (Fig. 38d); base of S8 strongly bilobed in ventral aspect (Fig.38c); Australian group . . . . . *Notomegilla*
5. Apical margin of S5 broadly emarginate, if entire, then hair on metasomal terga with metallic blue color (often only visible under a microscope); Australasian 6
— Apical margin of S5 entire; color of metasomal hair never metallic blue; mainly an Ethiopian groups with a few Oriental species 7
6. Gonostylus well developed (Figs. 39b, g), at least three times as long as wide; S7 without lateral subapical circular area (Fig. 39f); maxillary palpus 5- or rarely 6-segmented; hair on metasomal terga brown, black or gray, never metallic . . . . . *Asaropoda*
— Gonostylus reduced to a blister (Figs. 37a, f), at most as long as wide; S7 with lateral subapical circular area present (Fig. 37c); maxillary palpus 6-segmented; metasomal hair on terga almost always metallic blue, green or orange (except one species in India with white hair) . . . . . *Zonamegilla*
7. Apex of S7 greatly expanded laterally, much broader than long (Fig. 35l); only T3 and T4 with pale apical bands of hair; body length 14-18 mm; northeast Africa, India, Timor. . . . . *Dizonamegilla*
— Apex of S7 laterally expanded normally, about as broad as long (Fig. 35d); all metasomal terga with pale apical bands of hair (except for a Ghanan species which has T1 all black); body length 8-14 mm; mainly African group with only two Indian species . . . . . *Zebramegilla*
8. Gonostylus absent (Figs. 37f, 38h). . 9
— Gonostylus present, varying from a blister to an elongate appendage (Figs. 36a, f, k) 10
9. Galea long, in repose reaching at least to middle of midcoxa, at least 3 times as long as foretibia (galea measured from apex to maxillary palpus); apex of S8 emarginate between a pair of large obtuse lobes (Fig. 38f); Oriental species, mainly Indomalaysian (there are three Indian species which are at least 13 mm in length and their metasomal terga with all black hair or at least anterior half with orange hair) . . . . . *Glossamegilla*
— Galea of moderate length, reaching in repose at most to anterior edge of midcoxa, at most 2.5 times as long as foretibia (galea measured as above); apex of S8 relatively narrowly emarginate between a pair of small obtuse lobes (Fig. 37i) or with a single median

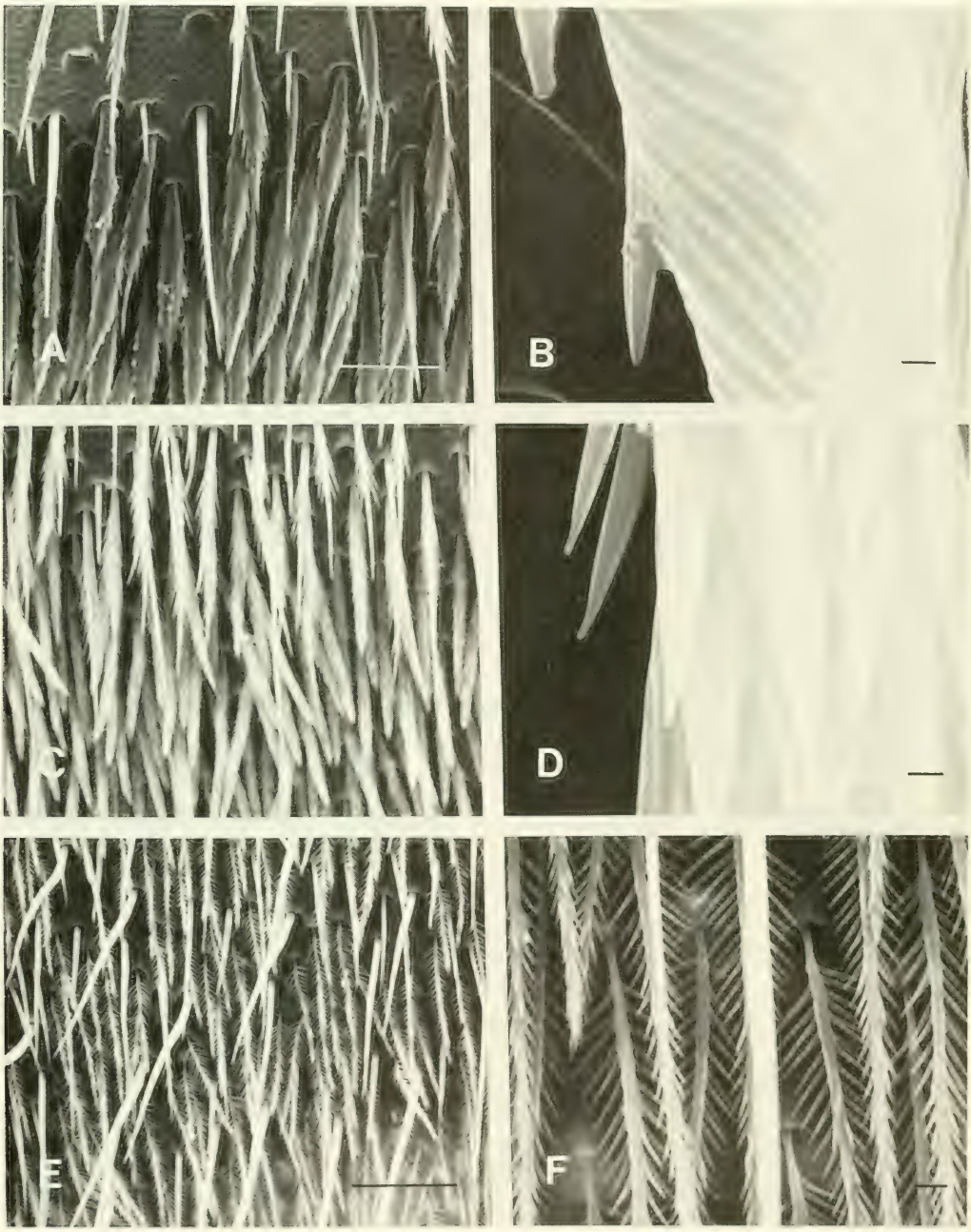


FIG. 34. Metasomal tergal hairs, dorsal view. Scale lines represent .1 mm in A, C, E, and .001 mm in B, D, F. A, B, *Amegilla (Dizonamegilla) sesquicincta,* showing flattened hairs (white in life) in lower two-thirds of Figure A and round hairs (black in life) in upper third and a close-up of a flattened hair showing oblique ridges in Figure B. C, D, *Amegilla (Zebramegilla) albigena,* showing white round hairs the shape of wheat tassles and a close-up of a single hair showing the longitudinal ridges. E, F, *Anthophora (Heliophila) bimaculata,* showing plumose (ochraceous in life) and simple (black or pale in life) hair and a close-up of same.

lobe; mainly Ethiopian species (there are two Indian species which are at most 12 mm in length and metasomal terga with pale apical bands) . . . . . *Micramegilla*

10. Apex of S7 with normal lateral expansion, midsection of disc without or with slight lateral tooth (Figs. 36d, i); S8 with apical emargination between pair of obtuse submedian lobes (Figs. 36c, l) 11
— Apex of S7 wide, with well developed lateral expansion, midsection of disc with well developed lateral tooth (Fig. 36h); S8 with apical margin entire or apicomedially with slight protuberance (Fig. 36e). . . . . *Ackmonopsis*
11. S8 with lateral margins of apical half to two-thirds converging distally (Fig. 36l); apex of gonocoxite from ventral aspect with small lobe on inner margin (Fig. 36k); basitibial plate sometimes present . . . . . *Aframegilla*
— S8 with lateral margins of apical half to two-thirds diverging distally (Fig. 36c); apex of gonocoxite from ventral aspect expanded and rounded, inner margin simple without lobe (Fig. 36a); basitibial plate absent . . . *Megamegilla*
12. Hair of metasomal terga metallic (sometimes only visible under a microscope), green, blue-green, blue or red-orange 13
— Hair of metasomal terga not metallic, white to ochraceous, brown, orange, yellow, gray or black 16
13. Galea usually moderate to short in length, reaching in repose at most to anterior edge of hind coxa, length at most 2.5 times length of foretibia (galea measured from apex to maxillary palpus); paraocular marks present or absent; Australian, Oriental or African groups 14
— Galea long, reaching in repose from middle to posterior edge of hind coxa, length about 3 times length of foretibia (galea measured from apex to maxillary palpus); paraocular marks absent; Malaysian group . . . . . *Glossamegilla* (in part)
14. Paraocular marks present; Australian or Oriental groups 15
— Paraocular marks absent; African groups . . . . . *Aframegilla* (in part)
15. Maxillary palpus with four, occasionally five segments; galea in repose reaching at most to anterior edge of midcoxa, length about twice as long as foretibia; length of flagellomere 1 equal to the combined lengths of the next 3.0-3.1 segments; Australian group . . . . . *Notomegilla*
— Maxillary palpus with six segments; galea in repose reaching at least past posterior edge of midcoxa, length 2.5 times as long as foretibia; flagellomere 1 equal to the combined lengths of the next 2.3-2.8 segments; Southeast Asian, Indian, Indomalaysian and Australian. . . . . *Zonamegilla* (in part)
16. Paraocular marks absent (Fig. 39d); maxillary palpus with five or six segments. 17
— Paraocular marks present (Figs. 37k, l); maxillary palpus with six segments 28
17. Ethiopian, Palearctic, or Oriental species; clypeus with pale integumental marking in form of inverted 'T' (Figs. 37k, l) or clypeus all to almost all black 18
— Australian species; clypeus completely pale except for small dark mark at anterior tentorial pit . . . . . *Asaropoda*
18. All metasomal terga with apical bands of hair, white to ochraceous. 19
— Some metasomal terga without apical bands of hair and/or with visible portion of some or all terga covered with dense, appressed white, ochraceous, yellow or orange pubescence 21
19. Posterior edge of hind tibia white without black band of scopal hairs . . . 20
— Posterior edge of hind tibia with band of black scopal hairs extending distally from basitibial plate to apical third. . . . . *Ackmonopsis* (in part)
20. Body length at most 12.5 mm; metasomal width at most 4.6 mm; length of flagellomere 1 equal to combined lengths of next 2.5-3.0 segments . . . . . *Micramegilla* (in part)
— Body length at least 12.7 mm; metaso-

mal width at least 5.0 mm; length of flagellomere 1 equal to combined lengths of next 3.0-3.3 segments . . . . . *Amegilla* s. str. (in part)

21. Pubescence of thorax brown to orange (sometimes with scattered dark hair); metasomal hairs usually almost all black, sometimes visible portions of terga with appressed white hair from apical margin of T3-T5 22
— Pubescence of thorax white, ochraceous, brown, black, or black and yellow (sometimes with scattered dark hair); metasomal terga with apical bands of hair and/or appressed hair on visible portions of T1-T5 or if T1-T3 (excluding apical margin of T3) all black, then scutum with white hair, black intermixed. 23

22. Maxillary palpus with five segments; body length at least 16 mm; length of flagellomere 1 equal to the combined lengths of next 3.0-4.2 segments . . . . . *Megamegilla* (in part)
— Maxillary palpus with six segments; body length at most 14 mm; length of flagellomere 1 equal to the combined lengths of next 3.0 segments. . . . . *Ackmonopsis* (in part)

23. Palearctic and Ethiopian species; clypeus with inverted T-shaped mark or reduced to a median longitudinal line, if clypeus all black then species from the Cape Verde Islands 24
— Oriental species (Indian region); clypeus all black or with small mark basomedially . . *Glossamegilla* (in part)

24. Scopal hair on outer surface of hind tibia all white (sometimes with a small patch of dark hair near basitibial plate) or all orange 25
— Scopal hair on outer surface of hind tibia all black. 26

25. Length of flagellomere 1 equal to combined lengths of next 2.5-3.0 segments; scutum with all white to ochraceous hair, no black intermixed or species almost all black with orange scopa . . . . . *Micramegilla* (in part)
— Length of flagellomere 1 equal to combined lengths of next 3.4-3.6 segments; scutum with brown to orange hair with some black intermixed or black and white intermixed . . . . . *Amegilla* (in part)

26. Metasoma either with T4 covered with white hair, T5 with lateral patch of white hair and remaining terga black or with T1 or T2-5 with appressed ochraceous to orange hair, not with distinct apical bands of hair though hair sometimes gradually becomes denser near apical tergal margins 27
— Metasomal T2-T5 with apical bands of white hair, without appressed pale hair on visible portions of terga. . . . . *Zebramegilla* (in part)

27. Maxillary palpus with five segments; pale mark on clypeus reduced so that inverted T-shaped mark is small, sometimes only represented by a median longitudinal line; supraclypeal mark small, almost absent . . . . . *Megamegilla* (in part)
— Maxillary palpus with six segments; inverted T-shaped pale mark of clypeus well developed; supraclypeal mark well developed (Figs. 43f, l) . . . . . *Aframegilla* (in part)

28. Species found in Oriental or Eastern Palearctic regions (East of 65th meridian) 29
— Species found in Ethiopian or Western Palearctic regions (West of 65th meridian) 33

29. T1 and T2 all black with no pale apical bands or appressed brown hair (T2 sometimes with white patch of hair laterally). 30
— T1 and T2 with pale apical bands of hair (sometimes weakly developed on T2) or most of visible portions of T1 and T2 with appressed brown hair (sometimes very sparse or absent medially) 31

30. Metasomal terga all black except a patch of white hair laterally on T5; propodeum with black hair . . . . . *Glossamegilla* (in part)
— T4 and sometimes T3 with apical bands of white hair; propodeum with white hair. . . . *Dizonamegilla* (in part)

31. Length at most 9 mm; thorax predominately with white hair, some

black intermixed; metasomal terga with apical bands of pale hair . . . 32

— Length at least 12 mm; thorax with brownish red hair, sometimes with black intermixed; metasomal terga with apical bands of brown hair, usually with appressed brown hair on some or all visible portions of terga, apically condensing into bands . . . . . *Glossamegilla* (in part)

32. Scape with yellow integumental marking anteriorly; paraocular mark large, ocular angle of mark at nearly same level as clypeal angle (Fig. 37k) *(A. niveocincta)* . . . . . *Zonamegilla* (in part)

— Scape with brown integumental mark anteriorly; paraocular mark normal, ocular angle of mark well below level of clypeal angle (Fig. 37l) (*A. quadrata* and *subcoerulea*) . . . . . *Zebramegilla* (in part)

33. Length at least 15 mm; at least T1 and T2 all black, without apical bands of pale hair 34

— Length at most 14 mm; T1-T5 with apical bands of pale hair . . . . . *Zebramegilla* (in part)

34. Yellow hair on scutum and apical margin of T2 and visible portions of T3-T6 *(A. atrocincta)* . . . . . *Micramegilla* (in part)

— White mixed with black hair on scutum; T1-T4 all black *(A. somalica)*. . . . . *Dizonamegilla* (in part)

Zebramegilla new subgenus

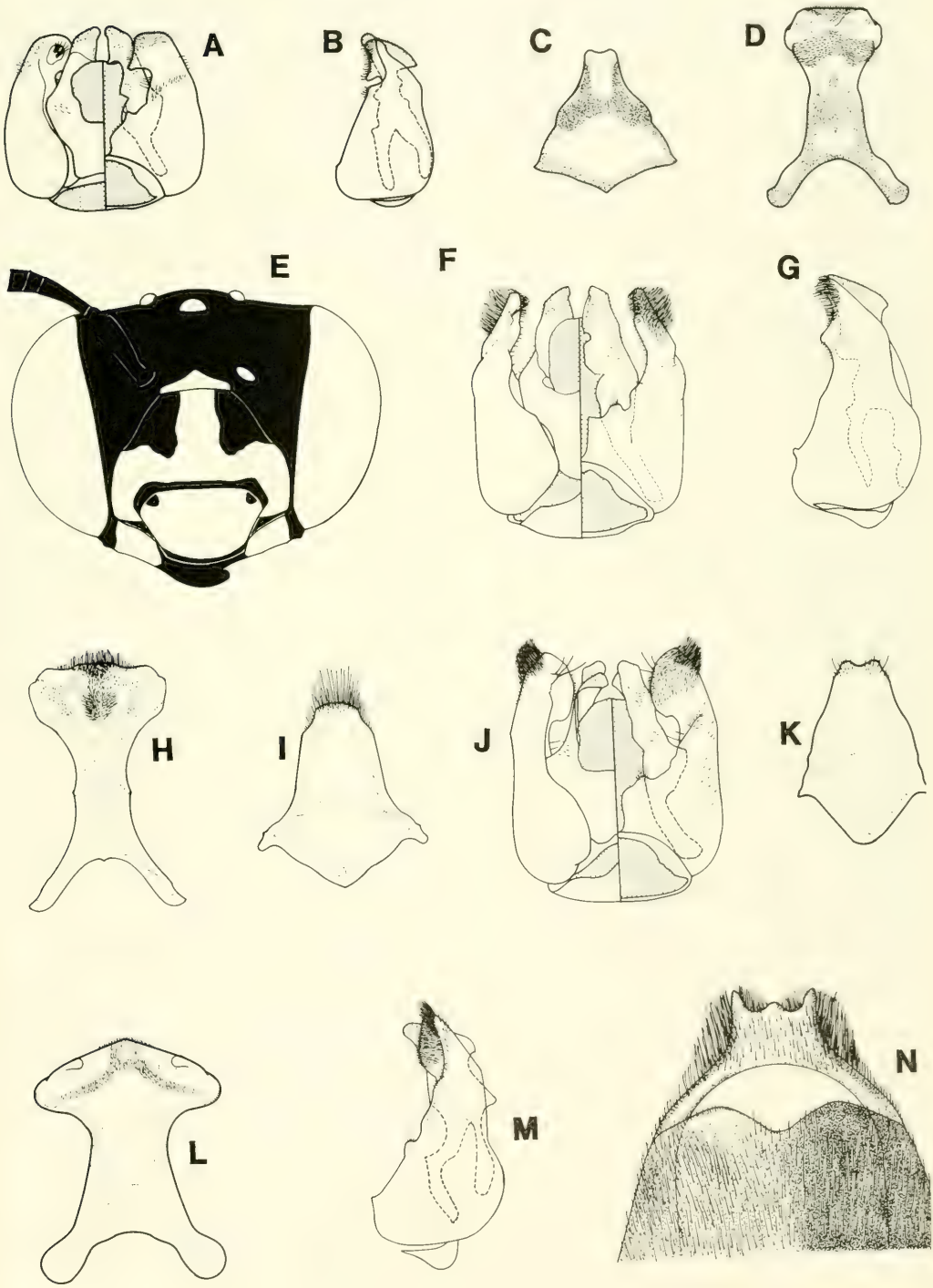
Type species: *Anthophora albigena* Lepeletier, 1841.

Diagnosis. Length 8-14 mm; S6 of male entire to shallowly emarginate; apex of S7 of male entire and rounded or trilobed, apicolateral margin rounded to angulate, submedian circular area present (Fig. 35d); apex of S8 of male apically narrowed, lateral margins on distal third to half converging distally (Fig. 35c); apex of gonocoxite of male dorsoventrally flattened, bent inward, inner apical margin subtruncate to rounded (Figs. 35a, b); gonostylus of male present (except the African *A. langi* absent) but reduced to a blister; T1-T5 with complete apical bands of hair (except *atribasis* with T1 all black).

Description. a. Length 8-14 mm. b. Flagellar segment 1 of female equal to length of next 2.5-4.0 segments together, of male equal to length of next 1.3-2.5 segments together. c. Mentum about .7 as long as prementum; paraglossa about as long as stipes; galea in repose attaining hind edge of forecoxa to anterior edge of midcoxa; maxillary palpus 6-segmented and labial palpus 4-segmented; face with white to yellow markings, paraocular marks present in male and female; wings clear (infuscated in *A. grandiceps*). d. Basitibial plate present in male. e. S6 of male medioapically entire to shallowly emarginate, disc flat (except *langi,* and *subcoerulea*), disc with lateral subapical depression, median longitudinal ridge on apical third (apicolateral margin with raised bump in *langi*). f. Apex of male S7 entire, apical margin straight to weakly trilobed with small acute lobe on each side of median one (except *michaelis* bilobed with broad emargination), lateral subapical carina often present, circular area present (except in *atribasis*); middle of expanded portion of disc sometimes with two submedian longitudinal ridges or a median tubercle on apical sixth but usually simple with a large patch of hair; apicolateral margin of disc expanded laterally either round or angulate, sometimes bilobed with a round (rarely carinate) dorsal lobe and a round ventral lobe; lateral margin on basal half simple or with lateral protuberance; longitudinal sclerotization present; length of apodeme .35-.55 length of disc (Fig. 35d). g. Apex of S8 of male narrowed, apicomedially bilobed (*atribasis* appearing quadrilobed); lateral margins on apical third to half converging distally, on basal half to two-thirds with weak lateral protuberance (Fig. 35c). h. T7 of male apicomedially tabulate usually with basal third to two-thirds thickened dorsoventrally, with two teeth, apical margin between teeth often with median lobe sometimes entire; T1-T5 with complete apical bands (except *atribasis* with T1 all black). i. Apex of gonocoxite of male on inner margin bent at almost a 90 degree angle inward, sometimes large, blunt, only slightly dorsoventrally flattened, subtruncate (Figs. 35a, b). j. Gonostylus of male present (in *langi* absent) as a blister. k. Apex of penis valve 2.0-2.7 times as long as broad, with small, scattered setae. l. Bridge of penis valves 1.0-2.6 times as long as wide, basally emarginate (except entire in *circulata*).

Etymology. Zebra (Amharic), Abyssinian name for the striped equine of Africa, plus *Megilla,* the name applied to a related taxon and serving as a

FIG. 35. *Amegilla* subgenera *Zebramegilla, Amegilla* s. str., and *Dizonamegilla.* A-D, *A. (Z.) albigena,* male; E-I, *A. (A.) quadrifasciata,* all male except E; J-N, *A. (D.) sesquicincta,* male. A, B, Genital capsule, dorsoventral and side views. C, D, S8 and S7, ventral views. E, Head. F, G, Genital capsule, dorsoventral and side views. H, I, S7 and S8, ventral views. J, Genital capsule, dorsoventral view. K, L, S8 and S7, ventral views. M, Genital capsule, side view. N, S6 and T7, ventral views.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stem for various names in this genus. The name *Zebramegilla* refers to the striped metasomas of this mainly Ethiopian group.

Comments. Many of the species of *Zebramegilla* are similar and difficult to separate. More synonymy will probably be established in the course of revisionary studies. Alfken (1926, p. 117) gave a key to four species of *Zebramegilla* from Egypt. *A. salviae* (Morawitz) is a valid name and need not be replaced by *A. pipiens* (Mocsáry) (see *Comments* for *Anthophora* s. str.)

Zebramegilla is closely related to *Amegilla* s. str. and can be separated from that subgenus by the characters given in the *Comments* for *Amegilla* s. str.

Biology. In subsaharan Africa the adults fly from August to May. In the Mediterranean region to India they fly from July to December.

Included Species. A. (Zebramegilla) albigena (Lepeletier), *alboscopacea* (Friese) new combination, *antimena* (Saussure), *atribasis* (Cockerell) new combination, *bechuanensis* (Cockerell) new combination, *bequaerti* (Cockerell), *calens* (Lepeletier), *cerealis* (Cockerell) new combination, *circulata* (Fabricius), *crocea* (Klug) new combination, *diloloensis* (Cockerell) new combination, *disrupta* (Cockerell) new combination, *eritrina* (Friese) new combination, *fallax* (Smith), *felina* (Friese), *ferrocincta* (Cockerell) new combination, *graeca* (Alfken) new combination, *grandiceps* (Friese) new combination, *harttigi* (Alfken), *kaimosica* Cockerell new combination, *langi* (Cockerell) new combination, *lomamica* (Cockerell) new combination, *madecassa* (Saussure) new combination, *mediorufa* (Cockerell) new combination, *melanocera* (Cockerell) new combination, *melanodonta* (Cockerell) new combination, *michaelis* (Cockerell) new combination, *nigritarsis* (Friese) new combination, *nubana* (Cockerell) new combination, *obscuriceps* (Friese), *ogilviei* (Cockerell) new combination, *omissa* (Priesner) new combination, *punctifrons* (Walker), *quadrata* (Cockerell) new combination, *rubricans* (Cockerell), *salviae* (Morawitz), *savignyi* (Lepeletier), *spilostoma* (Cameron), *subcoerulea* (Lepeletier), *supraferrea* (Cockerell) new combination, *talaris* (Pérez), *vanderysti* (Cockerell) new combination, and *zinniae* (Cockerell) new combination. This large group is found throughout Africa, the Mediterranean region to southern India.

Subgenus *Amegilla* Friese s. str.

Amegilla Friese, 1897, p. 18.

Type species: *Apis quadrifasciata* de Villers, 1789, designated by Cockerell, 1931a, p. 277.

Alfkenella Börner, 1919, p. 168.

Type species: *Apis quadrifasciata* de Villers, 1789. Original designation.

Diagnosis. Length 11.0-16.5 mm; S7 apically entire (see *Description*) with lateral subapical lightly sclerotized circular area (Fig. 35h); S8 apically more or less rounded (Fig. 35i); gonocoxite of male weakly bilobed apically as seen in profile; gonostylus of male absent (in *A. capensis* and *ochroleuca* reduced to blister); paraocular marks of female absent (Fig. 35e); metasomal terga with complete apical bands of hair, not metallic.

Description. a. Length 11.0-16.5 mm. b. Flagellar segment 1 of female equal to length of next 3.0-3.6 segments together, of male equal to length of next 1.2-1.8 segments together. c. Mentum .72-.85 as long as prementum; paraglossa 0.67-1.00 as long as stipes; galea in repose attaining anterior edge to middle of midcoxa; maxillary palpus 6-segmented; labial palpus 4-segmented; face with white markings (yellow in *A. capensis*), paraocular marks of female absent, of male well developed; wings clear (infuscated in some *quadrifasciata*). d. Male with basitibial plate. e. S6 of male narrowly and shallowly emarginate apicomedially (*garrula* and *confusa* with a small apicomedian protuberance). f. S7 of male apically entire (*garrula* and *confusa* broadly but shallowly emarginate) and with apicomedian patch of hair, apicolaterally weakly bilobed (single lobe in *capensis*), inner more weakly produced lobe ventral to outer dorsolaterally projected lobe; apex laterally with subapical lightly sclerotized circular area (absent in *capensis*); lateral margin of basal half with short tooth; disc with longitudinal sclerotization, length of apodeme .36-.43 length of disc (Fig. 35h). g. S8 of male more or less apically round, sometimes very weakly bilobed, lateral margin of apical half almost straight (Fig. 35i). h. T7 of male apicomedially bilobed; metasomal terga with complete apical bands of hair, not metallic. i. Apex of gonocoxite of male bilobed in profile, lateral margin of apical third somewhat angulate outwardly as viewed from ventral aspect, protuberance of lower ventral surface present to absent as viewed in profile, hair profuse to sparse on apicoventral surface (Figs. 35f, g). j. Gonostylus of male apparently absent, usually with gonostylar-like setae still present (except *capensis* and *ochroleuca* gonostylus present, but reduced to a blister). k. Apex of penis valve 1.4-2.1 times as long as wide as viewed apicodorsally; short, small setae present. l. Bridge of penis valves 1.2-1.6 times as long as wide, basally broadly emarginate to entire.

Comments. Amegilla s. str. is most closely related to *Zebramegilla* from which the males are separated by the S8 being not nearly as narrowed and rounded apically (Fig. 35i), its apodeme elongate and protruding and by S7 having a dense median patch of hair on its apex. Even though there is a size overlap between the two subgenera, most *Amegilla* s. str. are larger than *Zebramegilla.*

Alfken (1927) gave a key to some members of *Amegilla* s. str.

Biology. In southern and eastern Africa the adults are active from December to April. In the Northern Hemisphere the adults fly from February to October.

Included Species. A. (Amegilla) canifrons (Smith), *capensis* (Friese) new combination, *confusa* (Smith) new combination, *elgonica* (Cockerell) new combi-

nation, *farinosa* (Klug), *garrula* (Rossi), *incana* (Klug) new combination, *mauritanica* (Benoist) new combination, *ochroleuca* (Pérez), *quadrifasciata* (de Villers), *socia* (Klug) new combination, and *xerophila* (Cockerell) new combination. Members of this subgenus are found in eastern and southern Africa, the Mediterranean region, Central Europe, eastward to northern India.

Dizonamegilla new subgenus

Type species: *Megilla sesquicincta* Erichson and Klug, 1842 (=*Apis bicincta* Fabricius, 1793, nec Schrank, 1781).

Diagnosis. Length 14-18 mm; apex of S7 of male medioapically entire, produced bluntly and expanded laterally without lightly sclerotized submedian circular area (Fig. 35l); apex of S8 of male narrowly tapered, weakly bilobed, lateral margin almost straight (Fig. 35k); gonocoxite apically expanded, dorsoventrally flattened (Fig. 35j); gonostylus present, reduced to a blister.

Description. a. Length 14-18 mm. b. Flagellar segment 1 of female equal to length of next 3.2-3.5 segments together, of male about equal to length of next 1.7 segments together. c. Mentum .7 as long as prementum; paraglossa about as long as stipes; galea in repose surpassing slightly anterior edge of midcoxa; maxillary palpus with 6 segments; labial palpus with 4 segments; face with white markings, paraocular marks present in male but small, and in female well developed; wing infuscated. d. Basitibial plate present in male. e. S6 of male narrowly emarginate apicomedially (Fig. 35n). f. S7 of male medioapically entire, produced bluntly, apicolateral margin with large lobe, submedian circular area absent, carinate C-shaped area on apicosubmedian margin; disc with longitudinal sclerotization; length of apodeme about one-third length of disc (Fig. 35l). g. S8 of male with apex narrow, bluntly bilobed, lateral margin almost straight (Fig. 35k). h. T7 of male medioapically shelf-like, dorsoventrally flattened with median longitudinal ridge, and apically trilobed, median lobe about one-third length of lateral lobe (Fig. 35n). i. Gonocoxite of male apically simple, expanded, dorsoventrally flattened, (Figs. 35j, m). j. Gonostylus of male apparently absent. k. Apex of penis valve about 1.8 times as long as wide viewed apicodorsally, with small scattered setae. l. Bridge of penis valves about 1.1 times as long as wide, basally emarginate.

Etymology. The name *Dizonamegilla* refers to the two white bands of hair on an otherwise all black metasoma of the type species.

Comments. The relationship of *Dizonamegilla* with other subgenera of *Amegilla* remains obscure. However, its affinities seem to be with *Amegilla* s. str. and *Zebramegilla* from which it is separated by the limitation of apical bands of metasomal hair to the last two or three segments, by the laterally expanded apex of the male S7 and by the apically rounded apices of the male gonocoxites.

The name *Apis bicincta* Fabricius, 1793 is not available for the type of *Dizonamegilla* because of homonymy. The next available name is *Megilla sesquicincta* Erichson and Klug, 1842. The supposed type material of *sesquicincta* is in Berlin but none of the four specimens there is from the type locality nor of the proper sex. These specimens, however, are the same as *A. bicincta* Fabricius as traditionally interpreted. Since *sesquicincta* and *bicincta* Fabricius are the same species judging from their descriptions, the distinctiveness of the species, their type localities (both from India), and the Erichson and Klug material of *M. sesquicincta* in Berlin, I here designate a neotype of *Megilla sesquicincta* Erichson and Klug (see Neotypic Designations).

Biology. The adults are active from November to April.

Included Species. A. (Dizonamegilla) sesquicincta (Erichson and Klug) new combination, *somalica* (Magretti) new combination, and *tetrataeniata* (Gribodo) new combination. Each of three species of this subgenus occurs in a different region. *A. somalica* occurs in Somalia, *sesquicincta* in India and *tetrataeniata* in Timor.

Megamegilla new subgenus

Type species: *Apis acraensis* Fabricius, 1793.

Diagnosis. Length 13-19 mm; apex of S7 of male medioapically entire, laterally expanded, without lateral subapical circular area (Fig. 36d), median section of disc narrow; S8 of male apically broad, with apicomedian emargination, lateral margins either diverging or parallel distally (Fig. 36c); apex of gonocoxite of male dorsoventrally flattened (Fig. 36a); gonostylus of male present; basitibial plate of male absent; maxillary palpus with five segments.

Description. a. Length 13-19 mm. b. Flagellar segment 1 of female equal to length of next 3.0-3.7 segments together, of male about equal to length of next 1.6-2.0 segments together. c. Mentum about .75 as long as prementum; paraglossa about as long as stipes; galea in repose attaining anterior to posterior edge of midcoxa; maxillary palpus with 5 segments; labial palpus with 4 segments; face with white markings, paraocular mark present in male, present to absent in female; wing infuscated. d. Basitibial plate absent in male. e. S6 of male narrowly emarginate and sometimes ventrally flexed medioapically, at base of emargination a transverse depression sometimes present. f. S7 of male apicolaterally expanded, entire; median area of disc narrowed greatly; disc with longitudinal sclerotization; length of apodeme .24-.40 length of disc (Fig. 36d). g. S8 of male apically broad, emarginate medioapically, lateral margins either parallel or diverging distally (Fig. 36c). h. T7 of male medioapically bilobed. i. Apex of gonocoxite of male dorsoventrally flattened and expanded (Figs. 36a, b) (inner margin with lobe in *acraen-*

sis). j. Gonostylus of male like a blister to 6 times as long as wide. k. Apex of penis valve 2.0-2.4 times as long as wide viewed apicodorsally, with small and scattered setae on surface. l. Bridge of penis valves 0.6-1.0 times as long as wide, broadly emarginate basally.

Etymology. Megas (Gr.), large, plus *Megilla,* the name of a related taxon. *Megamegilla* refers to the large size of the bees of this group.

Comments. Megamegilla is closely related to *Aframegilla* and *Ackmonopsis.* It can be readily separated from these two by its large size, lack of metallic hair, lack of pale marks on the male scape, narrowly emarginate apex of male S8 without small pair of protruding lobes and laterally angulate rather than rounded. Except for the melanic forms (e.g., the *tellervo* form of *acraensis*) whose thoracic hair is a mixture of black and white), these bees are typically with dark heads with or without pale brown to yellow thoracic hair and black metasomas with or without white hair on the last two to three segments.

Biology. The adults fly from April to February.

Included Species. A. (Megamegilla) acraensis (Fabricius), *albocaudata* (Dours) new combination, *nativitatis* (Cockerell) new combination, *nigroclypeata* (Friese) new combination and *paradoxa* n. sp. *Megamegilla* is Ethiopian, found south of latitude approximately 15° North including Yemen.

Subgenus *Aframegilla* Popov

Aframegilla Popov, 1950, p. 260.

Type species: *Anthophora nubica* Lepeletier, 1841. Original designation.

Diagnosis: Metasomal dorsum (as well as thorax sometimes) of many species with metallic blue or green hair; apex of male gonocoxite, from ventral view, with an inwardly projecting blunt to acute process (Fig. 36k); gonostylus of male membranous to completely sclerotized (concolorous with apex of gonocoxite); S7 of male with apicolateral margin angulate (Fig. 36i); S8 of male with apex wide, shallowly emarginate medially, apicolaterally with small lobe (Fig. 36l).

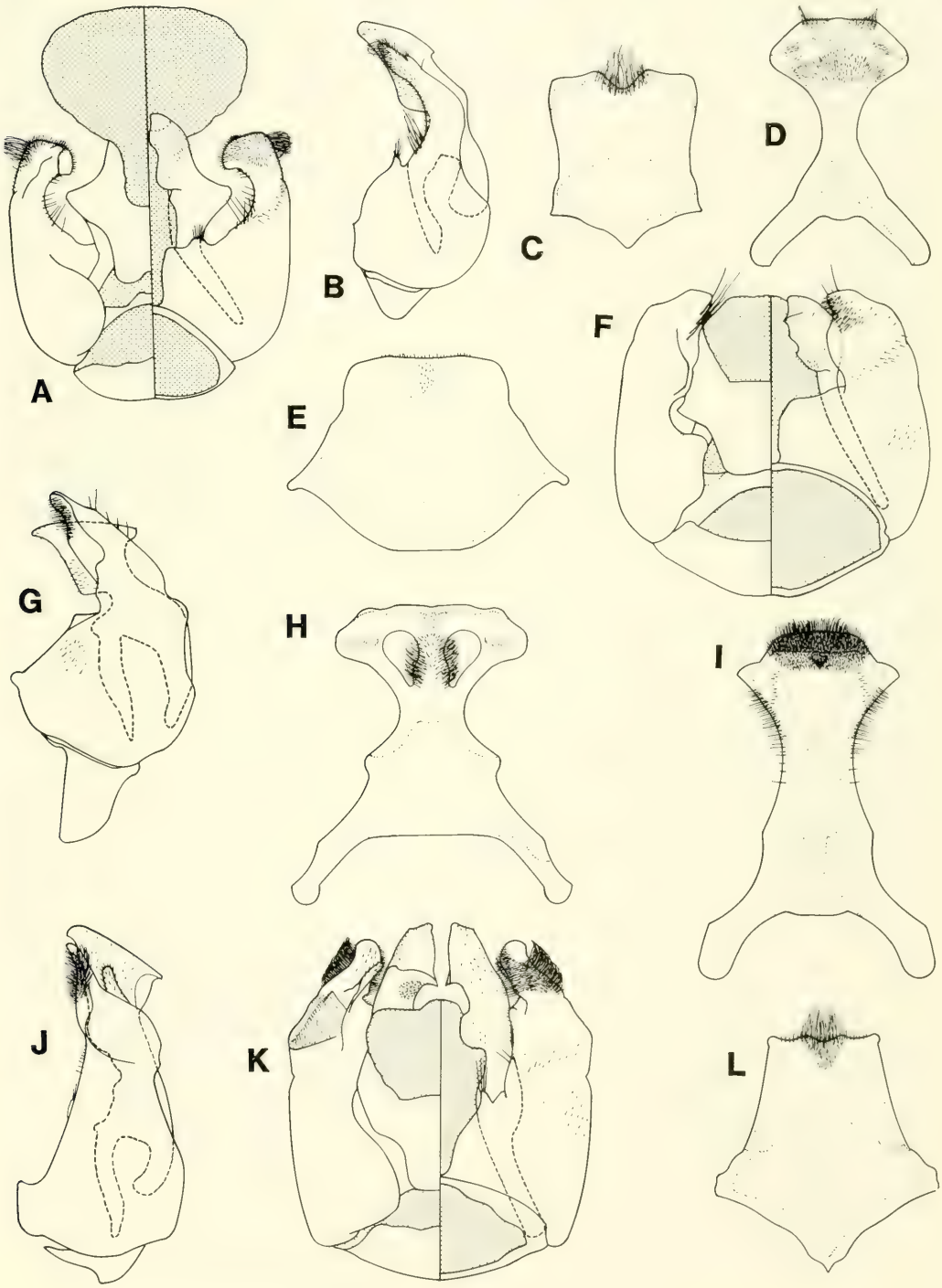
Description. a. Length 11.0-15.5 mm. b. Flagellar segment 1 of female equal to length of next 3.0-4.2 segments together, of male equal to length of next 1.7-2.6 segments together. c. Mentum about three-fourths as long as prementum; paraglossa about .7 as long as stipes; galea in repose attaining at most posterior edge of hind coxa; maxillary palpus with 6 segments; labial palpus with 4 segments; face with white integumental markings (yellow in *A. africana, robinae* and *triangulifera*), paraocular marks absent in female, well developed in male (absent in *cincta*); wing clear to infuscated. d. Basitibial plate of male absent to present. e. S6 of male apicomedially shallowly emarginate. f. S7 of male with apex medially emarginate, or produced, or rounded; lateral margin angulate apicolaterally and weak tooth on basal half (Fig. 36i) (an undescribed species from Magadi, Kenya with weakly developed tooth on basal three-fourths); disc with longitudinal sclerotization, length of apodeme .29-.40 length of disc (Fig. 36i). g. S8 of male with broad apex, apical margin variable from broadly to narrowly emarginate, to apicomedially produced and narrowly rounded, lateral margin of apical half relatively straight to lobed at basal half (Fig. 36l); longitudinal sclerotization present to absent. h. T7 of male medioapically bilobed to trilobed. i. Inner apical margin of gonocoxite of male, in ventral view, with acute to blunt lobe (Fig. 36k). j. Gonostylus of male membranous to sclerotized, when sclerotized, gonostylus not demarcated from gonocoxite (Fig. 36k), rounded (about as long as broad) to elongate (about 6 times as long as wide); ventral lobe of gonocoxite of male present. k. Apex of penis valve 1.2-2.2 times as long as wide as viewed apicodorsally, with small scattered setae. l. Bridge of penis valves 0.8-1.8 times as long as wide, basally broadly emarginate (except *aerizusa* basally entire).

Comments. Aframegilla is closely related to *Megamegilla* and *Ackmonopsis* and can be separated from them by the usual presence of a well developed male gonostylus, by the male S7 apicolaterally being acutely angulate, by the apicolateral margin of the male S8 having a small rounded lobe and usually by the presence of metallic hair. All African species of *Amegilla* with blue or metallic green tergal hair belong in *Aframegilla.* Nontypically, *A. africana* is covered with orange hair and the legs are all black and *nubica* has essentially a white thorax and black metasoma with T4 in the female (T3-T5 in male) covered with white hair.

Biology. The adults fly from October to July.

Included Species. A. (Aframegilla) aerizusa (Vachal), *africana* (Friese) new combination, *bothai* (Friese) new combination, *caelestina* (Cockerell) new combination, *caerulea* (Friese), *cincta* (Fabricius), *cyanipennis* (Saussure) new combination, *elsei* n. sp., *guinea* (Strand) new combination, *nubica* (Lepeletier), *regalis* (Cockerell) new combination, *robinae* n. sp., *terminata* (Smith), *triangulifera* (Cockerell) new combination and *vivida* (Smith) new combination. This Ethiopian subgenus only occurs south more or less of latitude 15° North.

FIG. 36. *Amegilla* males, subgenera *Megamegilla, Ackmonopsis,* and *Aframegilla.* A-D, *A. (M.) acraensis;* E-H, *A. (Ackmonopsis) mimadvena;* I-L, *A. (Aframegilla) nubica.* A, B, Genital capsule, dorsoventral and side views. C, D, S8 and S7, ventral views. E, S8, ventral view. F, G, Genital capsule, dorsoventral and side views. H, S7, ventral view. I, S7, ventral view. J, K, Genital capsule, side and dorsoventral views. L, S8, ventral view.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Ackmonopsis new subgenus

Type species: *Anthophora mimadvena* Cockerell, 1916.

Diagnosis. Length 12-15 mm; apex of S7 of male medioapically entire, greatly expanded laterally, submedian circular area present, basal half of disc relatively broad, with lateral tooth (Fig. 36h); S8 with broad apex essentially entire to weakly emarginate (Fig. 36e); apex of gonocoxite of male dorsoventrally flattened with inner margin bilobed or trilobed (Figs. 36f, g); gonostylus of male absent (a blister in *A. mimadvena*); basitibial plate of male present.

Description. a. Length 12-15 mm. b. Flagellar segment 1 of female about equal to length of next 3 segments together, of male equal to length of next 1.6-1.9 segments together. c. Mentum about .7 as long as prementum; paraglossa about as long as stipes; galea in repose attaining anterior edge of midcoxa; maxillary palpus with 6 segments; labial palpus with 4 segments; face with white or yellow markings, paraocular marks present in male, absent in female; wing infuscated. d. Basitibial plate present in male. e. S6 of male broadly, shallowly emarginate, apical margin flexed ventrally. f. Apex of S7 of male entire, margin rounded to straight, laterally expanded, anvil shaped, submedioapical circular area present, median patch of hair present, lateral margin on basal half with tooth; longitudinal sclerotization present; length of apodeme .37-.40 length of disc (Fig. 36h). g. S8 of male apically broad, apicomedially with shallow emargination to entire, lateral margins on apical fourth almost parallel (Fig. 36e). h. T7 of male apicomedially with shelf-like process, bilobed (weakly trilobed in *arcana*). i. Apex of gonocoxite of male with inner margin bilobed to trilobed as viewed from dorsal or ventral aspect, dorsoventrally flattened (Figs. 36f, g). j. Gonostylus of male absent (a blister present in *mimadvena*); ventral lobe of gonocoxite of male lightly sclerotized to absent. k. Apex of penis valve about 1.6 times as long as wide viewed apicodorsally, with small scattered setae. l. Bridge of penis valves 0.7-1.0 times as long as wide, broadly emarginate basally.

Etymology. Ackmon (Gr.), anvil, plus *opsis* (Gr.), having the appearance of, with reference to the apically broad S7 of the male.

Comments. Ackmonopsis appears to be closely related to *Aframegilla* and *Megamegilla.* It can be separated from *Megamegilla* by the smaller size, 6-segmented maxillary palpus and the pale marks on the scapes of the males. The subgenus can be separated from *Aframegilla* by the lack of metallic hair and the loss or great reduction of the gonostylus of male. Moreover, *Ackmonopsis* can be differentiated from the other two by the greatly expanded apex of the male S7 and by the simple shape of the male S8.

Biology. The adults in southern and central Africa fly from September to April. In Ethiopia and Yemen they fly from July to December. *A. arcana* and *mimadvena* look superficially like members of *Megamegilla,* probably due to Müllerian mimicry.

Included Species. A. (Ackmonopsis) arcana (Cockerell) new combination, *griseotecta* (Cockerell) new combination, and *mimadvena* (Cockerell) new combination. *Ackmonopsis* is found in eastern, central and narrowly into western Africa as well as Yemen.

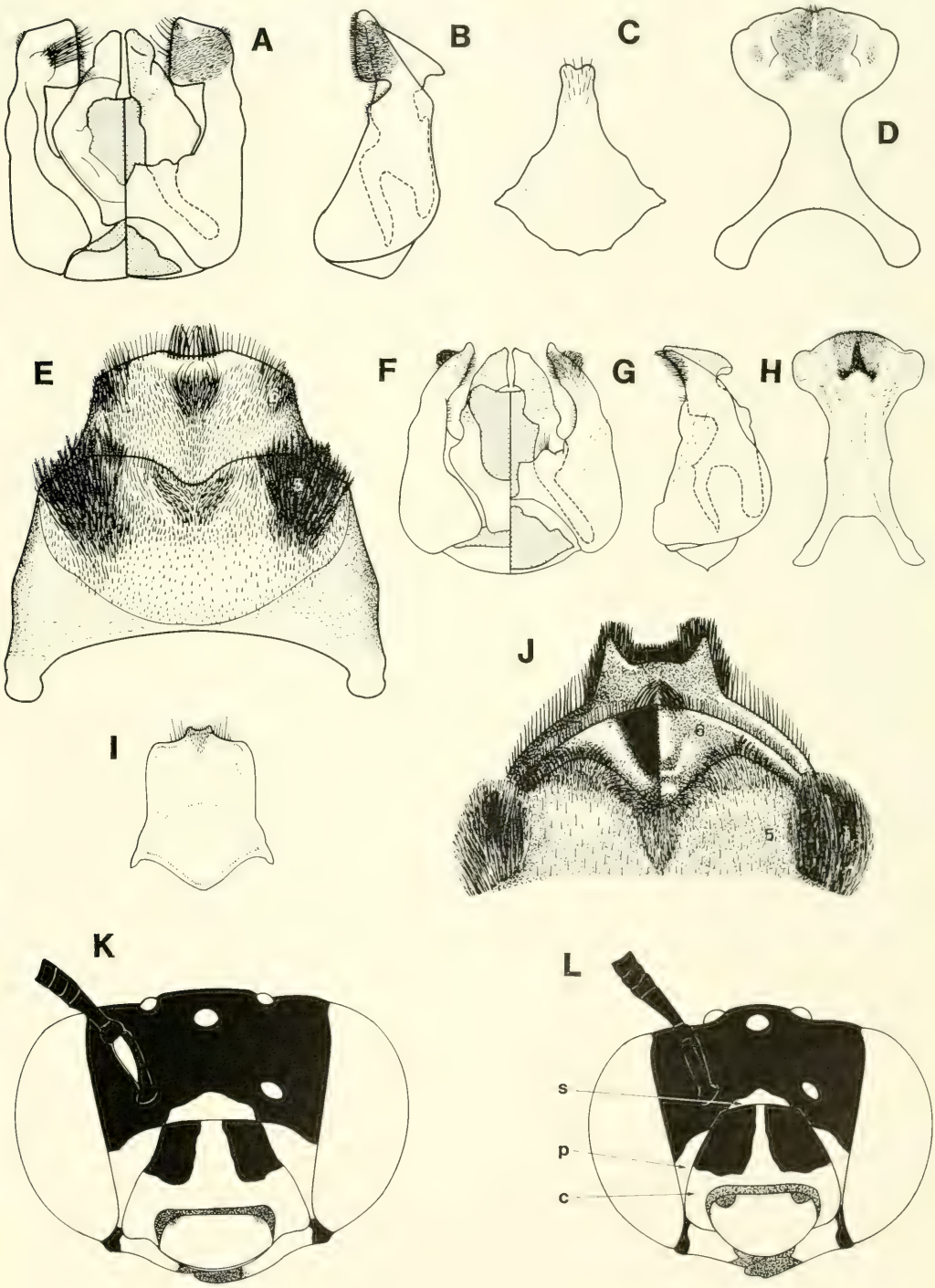
Micramegilla new subgenus

Type species: *Anthophora niveata* Friese, 1905.

Diagnosis. Length 9-18 mm; S7 of male medioapically entire with a dense patch of hair and without lateral, subapical, lightly sclerotized, circular area (see *Description*) (Fig. 37h); S8 of male medioapically bilobed, lobes small and close together, apex of S8 wide (Fig. 37i); gonocoxite of male apically simple and dorsoventrally flattened (Figs. 37f, g); gonostylus absent; paraocular marks absent in female (except in *A. atrocincta* see *Comments*).

Description. a. Length 9-18 mm. b. Flagellar segment 1 of female equal to length of next 2.5-3.0 segments together, of male equal to length of next 1.1-1.6 segments. c. Mentum .7 as long as prementum; paraglossa about as long as stipes; galea in repose at most attaining anterior edge of midcoxa; maxillary palpus 5- or 6-segmented; labial palpus 4-segmented; face with white to yellow markings, paraocular marks present to absent in male and absent in female (except in *A. atrocincta*); wings clear (infuscated in *godofredi*). d. Basitibial plate of male present or absent. e. S6 of male apicomedially shallowly emarginate (except *mucorea* entire). f. S7 of male usually broadly, shallowly emarginate (except *godofredi* and *niveata* entire and rounded, *maclachlani* entire and acute); apicolateral margin with rounded lobe; lateral margin with weak tooth in basal half to third (weakly developed in *godofredi,* straight in *maclachlani*); disc with longitudinal sclerotization; length of apodeme .32-.43 length of disc (Fig. 37h). g. S8 of male with broad apex, apicomedially bilobed; apicolateral margin rounded; lateral margin more or less straight to base of apodeme; longitudinal sclerotization absent (Fig. 37i). h. T7 of male apicomedially bilobed (some-

FIG. 37. *Amegilla,* subgenera *Zonamegilla* and *Micramegilla.* A-E, *A. (Z.) zonata* male; F-I, *A. (M.) niveata* male; J, *A. (Z.) andrewsi* male; K, *A. (Z.) niveocincta* female; L, *A. (Z.) quadrata* female. c = clypeal mark, p = paraocular mark, s = supraclypeal mark. Numbers refer to the metasomal sterna. A, B, Genital capsule, dorsoventral and side views. C-E, S8-S6, ventral views. F, G, Genital capsule, dorsoventral and side views. H, I, S7 and S8 ventral views. J, S5, S6, and T7, ventral views. K, L, Head.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times with weak median lobe) and occasionally shelf-like (i.e., *mucorea*). i. Gonocoxite of male apically simple dorsoventrally flattened (Fig. 37f, g). j. Gonostylus of male absent. k. Apex of penis valve 1.8-2.3 times as long as wide viewed apicodorsally, setae small and scattered. l. Bridge of penis valves 1.1-2.8 times as long as wide, basally entire (weakly emarginate in *nivescens,* broadly so in *maclachlani*).

Etymology. Mikros (Gr.), small, little, plus *Amegilla,* referring to the small size of many species in this group.

Comments. Micramegilla is most closely related to *Ackmonopsis* and *Aframegilla.* It is easily separated from *Ackmonopsis* by having apical bands and/or appressed hair on the metasoma. It is separated from *Aframegilla* by having non-metallic hair and no gonostylus in the male. *Micramegilla* resembles *Zebramegilla* from which it can be differentiated, along with *Ackmonopsis* and *Aframegilla,* by the shape of the male S8 which is somewhat quadrate with two small submedian apical lobes and by the male S7 which has a single rounded apicolateral lobe and short apodeme.

Many species are small, resembling *Heliophila,* having complete apical bands and/or appressed hair on the visible portions of the metasomal terga. *A. godofredi* is a striking species from the Cape Verde Islands. It is essentially all black with an apical band of pale hair on T1 and hair on the legs bright orange. *A. atrocincta* is also a non-typical member of *Micramegilla,* being a large yellow-haired bee with T1, T2 (except apical margin of T2), and legs all black.

Biology. The adults in subsaharan Africa fly from September to April. In the Middle and Far East they fly from April to September.

Included Species. A. (Micramegilla) andresi (Friese) new combination, *atrocincta* (Lepeletier) new combination, *byssina* (Klug) new combination, *canifronoides* n. sp., *capeverdensis* n. sp., *fasciata* (Fabricius) new combination, *godofredi* (Dours) new combination, *latizona* (Spinola) new combination, *maclachlani* (Fedtschenko), *modestoides* n. sp., *montivaga* (Fedtschenko), *mucorea* (Klug) new combination, *nigricornis* (Morawitz), *niveata* (Friese), *nivescens* (Cockerell) new combination, *velutina* (Friese), and *velocissima* (Fedtschenko). The distribution of this group extends from southern, central and eastern Africa (including the Cape Verde Islands) to the Mediterranean region of Europe and eastward to northern India.

Subgenus *Zonamegilla* Popov

Zonamegilla Popov, 1950, p. 260.

Type species: *Apis zonata* Linnaeus, 1758. Original designation.

Diagnosis. Australia to southeast China and India; length 10-14 mm; most species with metallic blue or green hair, or occasionally metallic orange, on metasomal terga (see *Description);* S5 of male apicomedially broadly to narrowly emarginate (Figs. 37e, j) (except the Indian *A. calceifera,* entire); S6 of male with deep lateral concavity on apical third, median longitudinal Y-shaped ridge on apical third, sometimes with median protuberance, tuft of black hair apicomedially or on protuberance, apex of apodeme simple without lateral projection (Figs. 37 e, j); S8 of male apically bilobed, narrowed (Fig. 37c); apex of gonocoxite triangular as viewed ventrally [except the Chinese *zonata,* quadrate (Fig. 37a)], bent inward; gonostylus of male reduced to blister or knob (see *Description,* character j).

Description. a. Length 10-14 mm. b. Flagellar segment 1 of female equal to length of next 2.3-2.8 segments together, of male equal to length of next 1.2-1.8 segments together. c. Mentum about .7 as long as prementum; paraglossa about as long as stipes; galea in repose attaining middle of midcoxa to anterior edge of hind coxa; maxillary palpus with 6 segments; labial palpus with 4 segments; face with white to yellow markings, paraocular marks present in male and female; wing infuscated to clear. d. Basitibial plate present in male. e. S6 of male on apical third of disc, with deep lateral concavity, median Y-shaped ridge between the two concavities, and patch of black hair apicomedially (Fig. 37j); apical margin entire, rounded (with apicomedian shallow emargination in *A. puttalama, walkeri,* and *zonata*), apex of apodeme simple, without lateral projection (Fig. 37e); S5 of male apicomedially broadly emarginate (Figs. 37e, j) (entire in Indian *calceifera*). f. Apex of S7 of male entire and rounded, occasionally apicomedially acute, laterally with subapical carina and circular area present; lateral margin without tooth on basal half (weak tooth present in *niveocincta*); longitudinal sclerotization present; length of apodeme .4-.5 length of disc (Fig. 37d). g. S8 of male apically narrow, bilobed; lateral margin on apical third converging distally (Fig. 37c). h. T7 of male apicomedially shelf-like, bilobed, apical margin between lobes entire (Fig. 37j) (rounded in *samarensis* and weakly emarginate in *walkeri*); hair on metasomal terga metallic blue or green (most species), metallic orange (a few species), or non-metallic orange (*dohertyi* from Timor) or all white (*niveocincta* from India). i. Apex of gonocoxite of male dorsoventrally flattened, triangular in ventral aspect [except *zonata* quadrate (Fig. 37a)] and bent inward. j. Gonostylus of male present (absent in Indian *niveocincta*), reduced to blister (in *calceifera* gonostylus as long as broad), with 4-8 setae (Fig. 37a). k. Apex of penis valve twice as long as broad (2.7 times as long as broad in *calceifera*) as viewed apicodorsally, with small scattered setae. l. Bridge of penis valves 0.9-2.0 times as long as wide, broadly emarginate basally.

Comments. Zonamegilla is most closely related to *Asaropoda* and *Notomegilla.* They are separated from *Asaropoda* by usually having an inverted T-shaped clypeal mark, having metallic metasomal hair, having a greatly reduced male gonostylus

and having a much more apically narrowed male S8. *Zonamegilla* differs from *Notomegilla* by having apically strongly emarginate S5 and S6 in the males, lacking a tooth on the apodeme of the male S7 and having the male S8 basally simple rather than bilobed. In addition, *Notomegilla* is restricted to Australia and *Asaropoda* to Australia, New Guinea and the Bismarck Archipelago.

Parts of *Zonamegilla* have been treated by Dover (Oriental — 1924), Rayment (Australia — 1939, 1944 [not 1942], 1947) and Lieftinck (Korea — 1975). Some of the Rayment species are probably synonyms but are listed below pending a revisional study.

Traditionally *Zonamegilla* have been referred to as the "blue banded bees" (Rayment, 1935) since almost all members have blue or green metallic hair in apical bands on the metasomal terga.

Biology. Michener (1960) described the nesting biology of *A. salteri.* Cardale (1968a-c) described the nesting biology, the larva, and associated parasites and predators of *pulchra.* The species fly year around.

Included Species. A. (Zonamegilla) adelaidae (Cockerell), *andrewsi* (Cockerell) new combination, *asserta* (Cockerell), *atripes* (Friese) new combination, *atrocaerulea* (Dours) new combination, *australis* (Rayment), *berylae* (Rayment), *binghami* (Schulz) new combination, *borneensis* (Cockerell) new combination, *buruensis* (Cockerell), *calceifera* (Cockerell) new combination, *cinctofemorata* (Dours), *cingulata* (Fabricius), *cingulifera* (Cockerell) new combination, *comberi* (Cockerell) new combination, *custos* (Dalla Torre) new combination, *dohertyi* (Gribodo) new combination, *dulcifera* (Cockerell), *elegans* (Smith), *fabriciana* (Rayment), *ferrisi* (Rayment), *flammeozonata* (Dours) new combination, *hackeri* (Rayment), *holmesi* (Rayment), *insignita* Brooks, *korotonensis* (Cockerell) new combination, *longmani* (Rayment), *longula* (Rayment), *mimica* (Rayment), *murrayensis* (Rayment), *niveocincta* (Smith) new combination, *parapulchra* (Rayment), *parhypate* Lieftinck, *perasserta* (Rayment), *perpulchra* (Rayment), *pulchra* (Smith), *puttalama* (Strand) new combination, *salteri* (Cockerell), *samarensis* (Cockerell) new combination, *sapiens* (Cockerell), *shafferyella* (Rayment), *stantoni* (Cockerell), *subsalteri* (Rayment), *ternatensis* (Cockerell) new combination, *thorogoodi* (Rayment), *vegeta* (Bingham) new combination, *walkeri* (Cockerell), *wallacei* (Cockerell), *whiteheadi* (Cockerell) new combination, *whiteleyella* (Rayment) and *zonata* (Linnaeus). *Zonamegilla* range from Australia (absent from Tasmania) to southeast China and India.

Notomegilla new subgenus

Type species: *Anthophora aeruginosa* Smith, 1854.

Diagnosis. Australian; length 9-12 mm; hair having a metallic green tint (sometimes only visible under a microscope; except male of *A. chlorocyanea* with white hair); S6 of male simple, convex without lateral depression, margin entire to shallowly emarginate medially; apex of S7 of male greatly expanded laterally suggesting *Ackmonopsis,* without lateral subapical circular area (Fig. 38d); apex of S8 of male narrowed, truncate or rounded, similar to that of *Amegilla* s. str. (Fig. 38c); apex of gonocoxite of male dorsoventrally flattened, bent inward and apicoventrally (Figs. 38a, b); gonostylus of male absent; maxillary palpus with 4 segments (*chlorocyanea* with 5).

Description. a. Length 9-12 mm. b. Flagellar segment 1 of female equal to length of next 3.0-3.1 segments together, of male equal to length of next 1.2-1.9 segments together. c. Mentum .7 as long as prementum; paraglossa about .8 as long as stipes; galea in repose attaining anterior edge of midcoxa or slightly less; maxillary palpus with 4 segments (5 in *A. chlorocyanea*); labial palpus with 4 segments; face with white or yellow markings, paraocular marks of male and female well developed; wings clear. d. Basitibial plate present in male. e. S6 of male simple, without lateral depression, apically entire to shallowly emarginate medially. f. Apex of S7 of male greatly expanded laterally as in *Ackmonopsis,* entire and rounded to flat medially, with dense transverse patch of hair, sometimes with median subapical protuberance; apicolaterally weakly bilobed with small upper lobe and large outer lobe or with only large outer lobe present, outer lobe sometimes with transverse carina mostly paralleling margin on distal half; lateral margin with tooth on basal half (*aeruginosa* in addition has tooth on basal third); lateral subapical circular area absent; longitudinal sclerotization present; length of apodome .38-.67 length of disc (Fig. 38d). g. Apex of S8 of male narrowed, either round or truncate; lateral margin on apical half converging distally (Fig. 38c). h. T7 of male apicomedially with two teeth, apical margin between teeth straight. i. Apex of gonocoxite of male dorsoventrally flattened, bent inward and then basally [*aeruginosa* also with apex laterally expanded on basally directed apex (Figs. 38a, b)]. j. Gonostylus of male absent; ventral lobe of gonocoxite of male present. k. Apex of penis valve 1.8-2.1 times as long as wide, subapically constricted, as viewed apicodorsally, with small and scattered setae. l. Bridge of penis valves 1.0-1.5 times as long as wide, broadly emarginate basally, not constricted but lateral margin round (Fig. 38a).

Etymology. Notos (Gr.), south, plus *Megilla,* a name of a related taxon. The name *Notomegilla* refers to the Australian distribution of this subgenus.

Comments. Notomegilla is closely related to *Zonamegilla* and *Asaropoda.* It is separated from these two by the light green metallic hair (not blue or bright green), the expanded apex of male S7 with a tooth on the apodeme and the apex of the male S8 more or less simple.

Some of the Rayment species are probably synonyms but are included below pending revisional study.

Included Species. A. (Notomegilla) adamsella (Rayment), *aeruginosa* (Smith), *chlorocyanea* (Cockerell), *grayella* (Rayment), *jamesi* (Rayment), *mewiella* (Rayment, *murrayi* (Rayment), and *sybilae* (Rayment). *Notomegilla* is endemic to Australia.

Glossamegilla new subgenus

Type species: *Anthophora mesopyrrha* Cockerell, 1930.

Diagnosis. Length 13-20 mm; pubescence brown (see *Comments*), thoracic hair short, dense, velvety, metasomal hair appressed, covering tergal discs evenly or only apically as bands; apex of S7 of male entire (broadly emarginate in the Indian *A. pseudobomboides*), rounded, apicolateral margin with one to two lobes (Fig. 38e); apex of S8 of male broad, bluntly bilobed, lateral margins slightly diverging to slightly converging distally (Fig. 38f); inner margin of gonocoxite of male with a rounded lobe (absent in *lieftincki*), apical lobe blunt (acute in *malaccensis*), gonocoxite of male not expanded apically (Figs. 38g, h); gonostylus of male absent.

Description. a. Length 13-20 mm. b. Flagellar segment 1 of female equal to length of next 2.7-3.5 segments together, of male equal to length of next 1.3-2.6 segments together. c. Mentum 0.7-1.0 as long as prementum; paraglossa 1.0-1.2 as long as stipes; galea in repose attaining middle of midcoxa to posterior edge of hind coxa; flabellum elongate and very narrow, often apically entire (e.g., *A. pseudobomboides*), if not with numerous short finger-like lobes; maxillary palpus with 6 segments; labial palpus with 4 segments; face with white to yellow markings (reddish-yellow in *himalajensis*), paraocular marks present in male and female (absent in females of *violacea* and *pseudobomboides*); wings infuscated. d. Basitibial plate present in male. e. S6 of male with shallow, apicomedial emargination (occasionally entire). f. Apex of S7 of male entire, round (except broadly emarginate in *pseudobomboides*), without lateral subapical circular area (except in *pseudobomboides*), often with lateral, subapical, transverse carina and with median, longitudinal ridge on apical third; apicolateral margin rounded, with one sometimes two lobes, rarely with one angulate lobe; lateral margin with tooth on basal half; longitudinal sclerotization present; length of apodeme .27-.44 length of disc (Fig. 38e). g. Apex of S8 of male broad, broadly emarginate; lateral margins slightly diverging to slightly converging distally; longitudinal sclerotization sometimes present (Fig. 38f). h. T7 of male apicomedially with two teeth, sometimes shelf-like between bases of teeth, apical margin between teeth straight to very slightly rounded; pubescence brown except in a few non-typically colored species discussed in *Comments*. i. Apex of gonocoxite of male usually blunt (acute in *malac-*

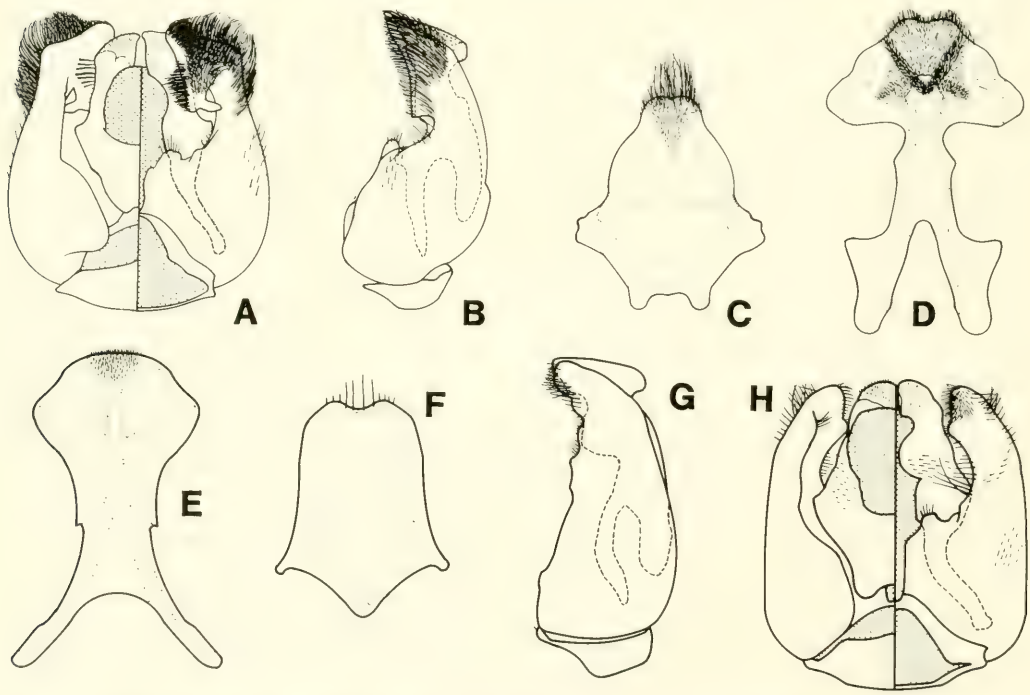

FIG. 38. *Amegilla* subgenera *Notomegilla* and *Glossamegilla*. A-D, *A. (N.) aeruginosa,* male; E-H, *A. (G.) mesopyrrha,* male. A, B, Genital capsule, dorsoventral and side views. C, D, S8 and S7, ventral views. E, F, S7 and S8, ventral views. G, H, Genital capsule, side and dorsoventral views.

censis), inner margin with one or two lobes (Figs. 38g, h). j. Gonostylus of male absent. k. Apex of penis valve 1.5-2.2 times as long as broad, with small scattered setae. l. Bridge of penis valves 0.8-1.5 times as long as wide, shallowly to deeply and broadly emarginate basally.

Etymology. Glossa (Gr.) tongue, plus *Amegilla*. The name *Glossamegilla* refers to the long tongues characteristic of the bees of this subgenus.

Comments. The relationship of *Glossamegilla* to the other subgenera of *Amegilla* remains uncertain. It seems to be closest to *Micramegilla*. *Glossamegilla* can be recognized by the following combination of characters: the usually brown appressed pubescence on the metasomal terga, S7 of the male wide apically with two blunt apical lobes and the apex of the gonocoxite of the male with one or two lobes. Besides the brown coloration, these bees have short, velvety thoracic and appressed metasomal pubescence and have long tongues, attaining as much as 11 mm for the galea and 23 mm for the glossa.

A. violacea is essentially all black with patches of white hair along the lateral margins of the metasomal terga, *fimbriata* has white and black hair intermixed on the thorax and a black metasoma with small lateral white patches of hair, and *pseudobomboides* is probably a bumble bee mimic having a yellow thorax, a black scutum and the metasoma all orange (male) or T1-T2 yellow, basal half of T3 black, apical half of T3 and subsequent terga orange (female).

Lieftinck (1944, 1956) described some new species, redescribed many others, and gave a key to the Malaysian members of *Glossamegilla*

Biology. The adults fly from May to March.

Included Species. A. (Glossamegilla) amymone (Bingham) new combination, *bouwmani* (Lieftinck), *brookiae* (Bingham) new combination, *cinnyris* (Lieftinck) new combination, *cyrtandrae* (Lieftinck), *elephas* (Lieftinck) new combination, *feronia* (Lieftinck) new combination, *fimbriata* (Smith) new combination, *florea* (Smith), *gigas* (Friese), *hanitschi* (Meade-Waldo) new combination, *himalajensis* (Radoszkowsky) new combination, *insularis* (Smith) new combination, *jacobi* (Lieftinck) new combination, *lieftincki* n. sp., *luzonica* (Cockerell) new combination, *malaccensis* (Friese) new combination, *mesopyrrha* (Cockerell), *pagdeni* Lieftinck, *pendleburyi* (Cockerell) new combination, *proboscidea* Lieftinck, *pseudobomboides* (Meade-Waldo) new combination, *subinsularis* (Strand) new combination, *subrussata* (Cockerell) new combination, *sumatrana* Lieftinck, *urens* (Cockerell) new combination, *vigilans* (Smith) new combination, *violacea* (Lepeletier) and *yunnanensis* Wu. *Glossamegilla* is distributed from India to southeast Asia into the Indomalaysian area where most of the species diversity is found.

Subgenus *Asaropoda* Cockerell

Asaropoda Cockerell, 1926, p. 216.

Type species: *Saropoda bombiformis* Smith, 1854. Original designation.

Diagnosis. Australian species (including New Guinea and the Bismarck Archipelago); length 13-24 mm; pubescence brown to gray (mostly black in *A. aurata* from New Guinea and the Bismarck Archipelago); maxillary palpus with 5 segments (see *Description*); apical margins of male metasomal sterna modified, S4 usually produced medially, rounded and having a thick brush of hair (hair omitted from Fig.) (Fig. 39a), S5 broadly and deeply emarginate (Fig. 39a), S6 shallowly emarginate medially with one to two dense patches of hair laterally (hair omitted from Fig.); S7 apically somewhat quadrate, medioapically emarginate (Fig. 39f); S8 apically narrowed (Fig. 39c); apex of gonocoxite of male bilobed with long, narrow, upper lobe and small ventral lobe (Figs. 39b, g); gonostylus of male well developed (Fig. 39b).

Description. a. Length 13-24 mm. b. Flagellar segment 1 of female about equal to length of next 2.8-3.1 segments together, of male equal to length of next 1.3-2.0 segments together. c. Mentum .6-.7 as long as prementum; paraglossa 0.7-1.1 as long as stipes; galea in repose attaining anterior edge of forecoxa to anterior edge of midcoxa; maxillary palpus with 5 segments (sixth is fused to fifth segment) (*A. aurata* from Bismarck Archipelago occasionally has 6); labial palpus with 4 segments; face with yellow to reddish-yellow markings, paraocular marks present in male (Fig. 39e), absent in female (Fig. 39d); wings clear to infuscated. d. Basitibial plate present in male. e. Apical margins of male S4-S6 modified, S4 with median tenth produced, rounded, with dense patch of black to reddish-brown hair, S5 with deep, broad median emargination and with 1 or 2 dense patches of hair laterally, S6 apically flexed ventrad with shallow, median emargination and median, longitudinal, rounded ridge on apical sixth of disc, laterally with dense patch of red-brown hair (hair omitted from drawing) (Fig. 39a). f. Apex of S7 of male somewhat quadrate, apicomedially entire or with small, shallow emargination, apicolateral margin rounded, lateral subapical carina often present, circular area absent, often with median longitudinal ridge on apical half; lateral margin with tooth on basal half, longitudinal sclerotization present; length of apodeme .41-.46 length of disc (Fig. 39f). g. S8 of male apically narrow, bilobed; lateral margins of apical fourth to half converging distally, margin angulate or straight (Fig. 39c); S8 basally more or less rounded (except *dawsoni* basally trilobed with lobes basally directed). h. Apex of T7 of male apicomedially with 2 widely separated teeth (except *dawsoni* shelf-like without teeth), apical margin between teeth straight (Fig. 39a). i. Apex of gonocoxite of male not dorsoventrally flattened but bilobed, with large, apical, elongate upper lobe and small blunt to acute, ventral lobe as viewed ventrally (Fig. 39b), in profile bilobed (Fig. 39g). j. Gonostylus of male present, well developed, 3-10 times as long as wide. k. Apex of

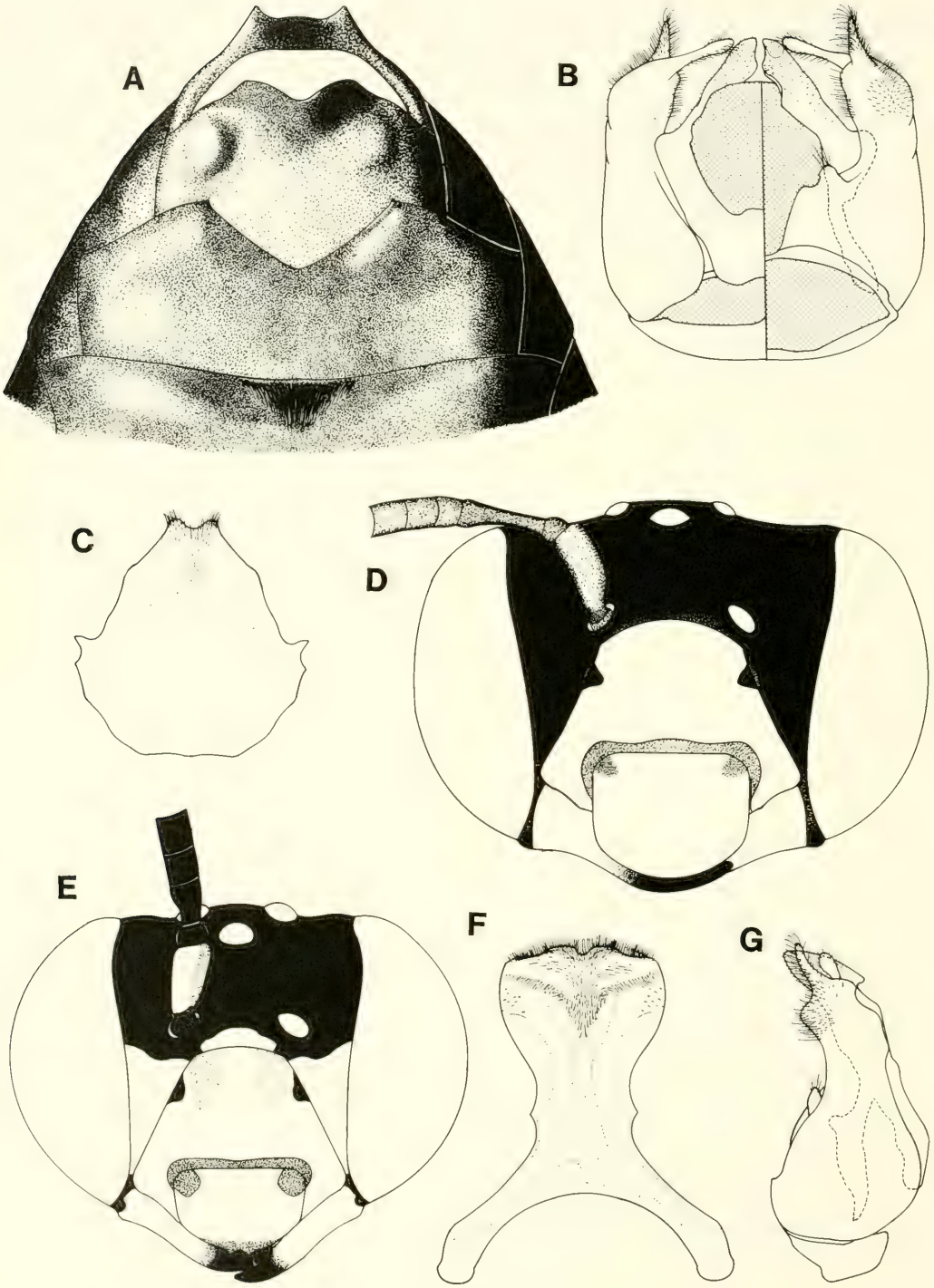

FIG. 39. *Amegilla (Asaropoda) bombiformis.* A-C, male; D, female; E-G, male. A, Apex of metasoma showing principally S5-S6 and T7 (hair omitted), ventral view. B, Genital capsule, dorsoventral view. C, S8, ventral view. D, E, Head. F, S7, ventral view. G, Genital capsule, side view.

penis valve 1.8-2.2 times as long as broad as viewed apicodorsally, with small scattered setae. l. Bridge of penis valves 0.6-1.6 times as long as wide, broadly emarginate basally.

Comments. Asaropoda is most closely related to *Zonamegilla* and *Notomegilla.* It is separated from the former by the lack of metallic hair, the presence of a well developed male gonostylus, the pale clypeus and characters of the male S7, S8 and genital capsule given in the *Comments* on *Zonamegilla.* It is separated from *Notomegilla* by the larger size, brown or gray pubescence, somewhat quadrate apex of the male S7 and presence of a well developed male gonostylus.

This group of bees has been given generic status by some authors (Cockerell, 1926; Cockerell, 1931b; Rayment, 1951), but is clearly only of subgeneric import considering many of the derived characters it shares with all other subgenera of *Amegilla.* Rayment (1951) treated the species of *Asaropoda* briefly, describing six new species but giving no key to species or good diagnostic characters for the group. Some of the Rayment species are probably synonyms but are included below pending a revisionary study. There are several species, both described and undescribed, which look superficially like *A. bombiformis.*

Traditional characters for *Asaropoda* have been the red-brown coloration and loss of the last two segments of the labial palpus, but it appears that these segments are easily broken off and in life there are four segments. Michener (1965) defined *Asaropoda* more clearly and recognized its affinity within *Amegilla,* giving it subgeneric status and building upon the work of Rayment (1951).

Biology. This group of bees flies year around. There is an apparent absence of *Asaropoda* from the dry interior of Australia, but this may be from lack of sufficient sampling.

In *Anthophora* turret-making is found only in species of the subgenus *Melea;* in *Amegilla* it is characteristic only of some species of the subgenus *Asaropoda.* A single female of *A. rickae* from Bolgart, Western Australia (Rayment, 1951) and a big aggregation of *dawsoni* from 160 miles (258 km) northeast of Carnavon, W. Australia (Michener, 1965) both were found with turrets over their nest burrows. Cardale (1968b-d) gave some biological notes about an unidentified species of *Asaropoda* and described its larva (Cardale, 1968c).

Included Species. A. (Asaropoda) albiceps (Rayment), *albigenella* Michener, *alpha* (Cockerell), *anomala* (Cockerell), *aurata* (Friese) new combination, *bombiformis* (Smith), *calva* (Rayment), *cygni* (Rayment), *dawsoni* (Rayment), *dentiventris* (Rayment), *epaphrodita* n. sp., *grisescens* (Rayment), *houstoni* n. sp., *imitata* (Rayment), *meltonensis* (Rayment), *preissi* (Cockerell), *punctata* (Rayment), *rhodoscymna* (Cockerell), *rickae* (Rayment), *rubricata* (Rayment), *rufa* (Rayment), *rufescens* (Friese), *scymna* (Gribodo), *sordida* (Rayment), *sordidula* (Rayment), and *victoriensis* (Rayment). This group is Australian (including New Guinea and the Bismarck Archipelago but not Tasmania).

Amegilla incertae sedis

The following species of *Amegilla* cannot be placed with certainty into a subgenus because the males are unknown, the types are lost, destroyed or have not been studied yet: *A. advenula* (Cockerell) new combination, *annos* (Vachal) new combination, *aspergina* (Cockerell), *atriceps* (Radoszkowsky), *bucharica* (Gussakovsky), *caffra* (Friese) new combination, *caldwelli* (Cockerell), *camelorum* (Cockerell), *cana* (Walker) new combination, *candens* (Pérez), *candida* (Smith) new combination, *candidella* (Priesner), *centralis* (Cockerell) new combination, *deltoides* (Buysson) new combination, *expleta* (Vachal) new combination, *glycyrrhizae* (Gussakovsky), *gussakovskyi* (Popov), *hypocyanea* (Cockerell) new combination, *karakumensis* (Gussakovsky) new combination, *katangensis (Cockerell) new combination, liberica* (Cockerell) new combination, *lutulenta* (Klug), *macroleuca* (Cockerell), *maculicornis* (Lepeletier) new combination, *marqueti* (Pérez), *mephistophelicana* (Strand) new combination, *nigropilosa* (Friese) new combination, *nivea* (Lepeletier) new combination, *nonconforma* n. sp., *potanini* (Morawitz) new combination, *pulverea* (Walker) new combination, *rapida* (Smith) new combination, *ruficornis* (Dours) new combination, *rufipes* (Lepeletier) new combination, *semipulverosa* (Dours), *senegalensis* (Friese) new combination, *simbana* (Cockerell) new combination, *sjoestedti* (Friese) new combination, *subtorrida* (Cockerell) new combination, *torensis* (Priesner) new combination, *tubifera* (Cockerell) new combination and *vestitula* (Cockerell) new combination.

CLADISTIC ANALYSIS

Using a list of variables for which polarity could be determined with reasonable confidence, I have developed a list (Table 1) of 70 apomorphous tribal, generic and subgeneric characters found in the tribes Anthophorini and Habropodini, the genera *Anthophora* and *Amegilla* and the subgenera of *Anthophora.* A similarly constructed list (Table 3) of 17 apomorphic characters was compiled for the subgenera of *Amegilla.* The distribution of these characters among the taxa, i.e., the data on which the cladograms are based, are given in Tables 2 and 4 respectively. Cladistic methodology is discussed in the section on Methods. Because decisions on what taxa to recognize were made after the cladistic analysis, some species groups, not now recognized as taxa, were included as separate entities in the study. Table 1 therefore includes some characters relevant to those groups but not used as subgeneric characters.

TABLE 1. LIST OF VARIABLES OF SUBGENERA OF *ANTHOPHORA* AND THE TRIBES ANTHOPHORINI AND HABROPODINI.

For each variable (1-70) a synapomorphous state is coded as (1). A state of (2) or more is a further derivation of synapomorphous state number (1). Plesiomorphous states are listed in brackets and coded as 0. 1-59 are variables useful within *Anthophora,* variables 60-70 concern the tribes Anthophorini and Habropodini.

1. Flagellar segment 1 of female equal to total length of more than four succeeding segments (Fig. 7a) (2). Flagellar segment 1 of female equal to total length of more than three to four succeeding segments (1). [Flagellar segment 1 of female equal to total length of three or fewer succeeding segments (Fig. 7b).] Habropodine, eucerine, melitomine and exomalopsine bees all have a relatively short first flagellomere which is therefore considered the plesiomorphic state.

2. Face of male with white markings (1). [Face of male with yellow markings.] Almost all non-parasitic Anthophoridae, as well as most bees which have pale-faced males, have yellow facial markings on the males.

3. Face of female with pale integumental marking on clypeus (1). [Face of female black.] A female with integumental facial marking is rare in the Anthophorinae except in the Anthophorini. Only a few species of habropodines have such markings. Among the exomalopsine bees facial markings in females are unknown, and presumably this is the plesiomorphous state. Pale facial markings are found in almost all females of *Amegilla* and *Anthophora (Heliophila).* This character has independently arisen in various subgenera of *Anthophora.*

4. Pale paraocular mark of male absent (1). [Pale paraocular mark of male present.] The polarity of this variable is uncertain since many exomalopsine males, all male melitomines and almost all male eucerines have black paraocular areas. Almost all habropodine and anthophorine males, however, have pale paraocular marks. It seems that all species that have males with black faces have close relatives which have the pale paraocular marks. Therefore, the apomorphous state within the Anthophorini seems to be loss of the pale paraocular marks.

5. Pale paraocular marks in female present (1). [Pale paraocular marks in female absent.] There are almost no females in the Anthophorinae with pale paraocular marks except for *Amegilla* (a few *Amegilla* have lost these marks). Therefore the presence of these marks presumably is an apomorphy.

6. Face of female flattened, clypeus with erect, apically hooked or wavy setae and often basally with a pecten, that is, a transverse row of stout erect flattened bristles (Fig. 17b) (1). [Face of female moderately to strongly protuberant with unspecialized, gently curved setae.] In the Anthophorini this synapomorphy is unique to *Mystacanthophora* (most species). This distinctive derived condition is also found in *Amegilla paradoxa* n. sp., in two species of *Habropoda,* in many species of *Deltoptila,* in *Trachusa (Ulanthidium),* an undescribed subgenus of South American *Megachile* (Moure pers. comm.), *Pectinapis,* two species of *Andrena* and one species of *Xenoglossodes.* This widespread phenomenon is possibly linked to some foraging adaptation.

7. Labrum of male apically trilobed (Fig. 25i). [Labrum of male apically entire.] The apically trilobed labrum has independently arisen at least twice in the Anthophorini but is not found in other Anthophorinae.

8. Labrum of female with median subapical bituberculate projection (Fig. 32a). [Labrum of female simple.] A synapomorphy of a group of African *Heliophila.*

9. Malar space of female strongly elongate, less than three times wider than long (2). Malar space of female wide, three times wider than long (1). [Malar space of female linear, five or more times wider than long.] The elongation of the malar space to provide space for the increased length of the mouthparts is an obvious apomorphy found only in some *Melea,* all *Rhinomegilla* and *Anthomegilla* in the Anthophorini.

10. Mandible of male simple (1). [Mandible of male with subapical tooth.] This is an apomorphy of some *Heliophila,* other Anthophorini and Habropodini have males with an upper mandibular tooth.

11. Mandible tridentate, with upper and lower subapical teeth (1). [Mandible bidentate, without lower subapical tooth.] The tridentate mandible is unique to *Clisodon* and is an adaptation to nesting in wood.

12. Flabellum apically simple, elliptical as viewed from in front (1). [Flabellum with apical margin deeply and numerously lobed or simple or as in variables 13 and 14.] The apomorphy is unique to *Anthophora* s. str.

13. Flabellum apically simple, apical two-thirds narrowed and parallel sided (Fig. 25d) (1). [Flabellum apically with several long finger-like lobes.] This is an unique apomorphy of *Anthomegilla.*

14. Flabellum long, with numerous small lobes on apical margin (Fig. 26b) (1). [Flabellum with apical margin deeply lobed or simple.] This autapomorphy is found only in *Rhinomegilla.*

15. Galea with a "double chambered lumen" (Fig. 5c) (1). [Galea with a single narrow lumen (Fig. 5b).] Melitomine, eucerine and centridine bees all have a single narrow galeal lumen. The "double chambered lumen" is unique to *Amegilla.*

16. Sixth segment of maxillary palpus equal to about half length of fifth (1). [Sixth segment of maxillary palpus about equal to length of fifth.] Among those tribes of the Anthophorinae which have a six-segmented maxillary palpus such as exomalopsine, melitomine and habropodine bees, the sixth is about equal in length to the fifth as it is in *Anthophora*. *Amegilla* has a reduced sixth segment, an apomorphy.

17. Basistipital process bilobed (Figs. 25a, 25e, 25f) (1). [Basistipital process with one projection (Fig. 5d).] Habropodine, centridine, eucerine and melitomine bees have a basistipital process with one projection. *Anthophora* has a secondary projection on the process.

18. Scape anteriorly with dense pilosity such that integumental surface is hidden (1). [Scape with pilosity anteriorly sparse to absent.] The derived condition is found only in some *Heliophila*.

19. Mentum with long anterior tooth near basal third (Fig. 22k) (1). [Mentum simple (with single, short tooth only in *A. (Dasymegilla) excisa)* near basal third.] This strong synapomorphy unites *Melea* and *Anthophoroides*.

20. S7 of male as wide as long, rather square in ventral aspect, sides almost equal in length and lateral margins almost parallel (Fig. 18d) (1). [S7 of male not square in ventral aspect, width less than length, lateral margins converging apically.] This apomorphy is found only in *Caranthophora*.

21. Midtarsal brush of male present (Fig. 2h) (1). [Midtarsal brush of male absent.] This apomorphic character is found almost exclusively in *Pyganthophora* and its relatives; except for a few other species of *Anthophora,* it is unknown in other Anthophoridae.

22. Midbasitarsal brush of male present (Fig. 29b) (1). [Midbasitarsal brush of male absent.] See comments on character 21, except this has independently evolved in *Caranthophora*.

23. Middistitarsal brush of male present (Fig. 2h) (1). [Middistitarsal brush of male absent.] See comments on character 22.

24. Hind basitarsus of male modified with tooth and/or ridge (1). [Hind basitarsus of male simple.] Most *Anthophora* and all *Amegilla* males have simple hind basitarsi. This modification of the hind basitarsus apparently has arisen once in the Anthophorini and is an apomorphy.

25. Basitibial plate of female pointed apically (Fig. 29b) (1). [Basitibial plate of female apically rounded.] This is a unique character found in *Clisodon*.

26. Basitibial plate of male poorly defined to absent (1). [Basitibial plate of male present, well defined.] Presumably the genetic expression in the female to produce a basitibial plate is carried over and expressed in the male. Though the polarity of this character is uncertain, I believe that the loss of the basitibial plate in the male is an apomorphy.

27. Hind tibia of female with posterior margin with simple hairs (Fig. 22h) (1). [Hind tibia of female with posterior margin with plumose hairs.] This character is unique to three small groups of *Anthophora*. The remaining *Anthophora,* all *Amegilla* and Habropodini have plumose posterior zones of hair on their hind tibiae and thus the simple hair in this zone probably is an apomorphy.

28. Hind femur and tibia of female with white appressed plumose hairs almost completely obscuring outer surfaces (Fig. 32l) (1). [Hind femur and tibia of female without appressed plumose hairs on outer surfaces.] This apomorphy is unique to some *Heliophila*.

29. Hind basitarsus of female with posterior distal process acute (Fig. 22h) (1). [Hind basitarsus of female with posterior distal process rounded.] This is an autapomorphy of *Melea*.

30. Apex of hind tibia of male with anterior spine, hind tibial spurs separated such that one spur is inserted near apex of spine and the other in the corium (Fig. 24j) (1). [Apex of hind tibia of male simple, hind tibial spurs normal, in close approximation and both inserted in the corium.] In the Anthophorini this is an autapomorphy of *Anthophoroides* and rarely seen in other Anthophorinae. Such a peculiar modification of the male hind tibia must be an apomorphy.

31. Posterior inner surface of female hind basitarsus with longitudinal cavity (Fig. 18h) (1). [Posterior inner surface of female hind basitarsus convex or angulate.] This character is unique to *Caranthophora*.

32. Hind femur of male dilated, bulbous (Figs. 24i, 24j) (1). [Hind femur of male normal, slender.] Such a peculiar modification of the male hind femur is not necessarily correlated with a toothed hind basitarsus. This unusual modification must be an apomorphy.

33. Pygidial plate of male with carinate margins, dorsally flattened (Fig. 13c) (1). [Pygidial plate of male, if present, without carinate margins.] Carinate margins are unique to *Pyganthophora*. I am uncertain as to whether the presence or absence of a male pygidial plate is apomorphic. Following the reasoning given in character 26, a pygidial plate on a male may be an apomorphy. Males of *Amegilla,* eucerine, melitomine and exomalopsine bees all lack pygidial plates but habropodine bees possess them. Even though the Habropodini are the sister group to the Anthophorini, almost all the rest of the male Anthophorinae lack pygidial plates and thus I believe the presence of one is an apomorphy. On the other hand, the presence of a male pygidial plate could be an apomorphy indicating sister group relationship of the Anthophorini and Habropodini. The loss of the pygidial plate would then be an apomorphy within the Anthophorini.

34. Pygidial plate of male without carinate margins but dorsally rounded (Fig. 15c) (1). [Pygidial

plate of male absent or if present, dorsally flattened.] See comments under character 33. This modification of the male pygidial plate is a weak apomorphy since it apparently has arisen several times in the Anthophorini.

35. Gradular process of T7 of male present (Fig. 2g) (1). [Gradular process of T7 of male absent.] This structure among the Anthophorinae is found only in a few groups of Anthophorini and Eucerini. This unusual modification is therefore considered an apomorphy.

36. Apical margin of T7 of male deflexed anteriorly, deflexed portion wide (Fig. 27f) (1). [Apical margin of T7 of male deflexed anteriorly, deflexed portion narrow.] This apomorphy is unique to *Dasymegilla*.

37. Apical margin of S6 of male emarginate (1). [Apical margin of S6 of male entire.] Some species of *Amegilla* have a slightly emarginate S6. All Habropodini have an apically entire S6. An emarginate sternum is probably an apomorphy.

38. S6 of male with pair of oblique ridges diverging distally on apical half (Fig. 14d) (1). [S6 of male without ridges.] A unique structure found only in *Lophanthophora*.

39. S6 of male with dense pad of hair on basal half of disc, not situated in a depression (Fig. 27f) (1). [S6 of male sparsely pubescent, if with a dense pad, then pad situated in a depression.] This structure is unique to *Dasymegilla*.

40. S5 and 6 of male (sometimes 4) with a dense pad of hair in depression and covering most of disc (Fig. 30a) (1). [All sterna without dense pads of hair in special depressions.] This is an apomorphy of some Old World *Heliophila*.

41. S7 with short apodemes, length of apodeme much less than length of disc (Fig. 32e) (1). [S7 with long apodemes, subequal to length of disc.] Long apodemes are found in most *Anthophora* and *Amegilla*. The apodemes are extremely short only in *Caranthophora* (Fig. 18d). Most *Heliophila* have moderately short apodemes.

42. Apodeme of S7 with strong lateral projection (Fig. 27d) (1). [Apodeme of S7 simple.] This synapomorphy is unique to *Petalosternon* and *Dasymegilla* and not found in the outgroups.

43. S8 with narrow apex (Fig. 26e) (1). [S8 with wide apex.] The apex of S8 of melitomine, eucerine, and centridine bees is wide. Presumably a narrow apex in certain anthophorine groups is an apomorphy.

44. S8 with long spiculum (Fig. 25c) (1). [S8 with normal, short spiculum.] This structure is unique to *Anthomegilla*.

45. Gonostylus absent (2). Gonostylus short, ten times or less longer than wide (1). [Gonostylus long, more than ten times longer than wide.] Exomalopsine to habropodine bees have narrow, elongate gonostyli. The gonostylus has been reduced apomorphically in many anthophorine groups.

46. Gonostylus sclerotized, concolorous with gonocoxite (1). [Gonostylus absent or membranous, lighter in color than gonocoxite.] This apomorphy is unique to *Clisodon*.

47. Penis valve apex small or greatly narrowed, at most 1.5 times as long as wide (Fig. 19a) (1). [Penis valve apex large, not narrowed, greater that 1.5 times as long as wide.] A large penis valve apex is found in melitomines and eucerines. The penis valves have become greatly reduced in many groups of *Anthophora,* this reduction presumably is an apomorphy.

48. Penis valve bridge long and narrow, at least 1.5 times as long as wide (1). [Penis valve bridge short and broad, less than 1.5 times as long as wide.] It appears that an elongation and narrowing of the penis valve bridge basally is an apomorphy since all non-anthophorine Anthophorinae have a broad triangular penis valve bridge with no basal elongation. Within the Anthophorini the bridge has been elongated up to three times as long as wide.

49. Base of penis valve bridge elongate and emarginate (Fig. 2d) (1). [Base of penis valve bridge simple.] In the Anthophorinae, excluding the anthophorine bees, the penis valve bridge is broad, triangular and apically simple. Thus, an apomorphy in the Anthophorini is a basal elongation usually accompanied by an emargination.

50. Penis valve bridge basally prolonged as an acute projection (Fig. 26h) (1). [Penis valve bridge without basal acute projection, instead basally blunt or emarginate.] This apomorphy is unique in *Rhinomegilla*.

51. Penis valve bridge without basal elongation but with deep emargination (Fig. 25f) (1). [Penis valve bridge basally elongated.] This condition is only found in *Anthomegilla*.

52. Apex of gonocoxite complex, with two subapical plate-like carinae, one dorsoventral, the other lateral (Figs. 16j, 16k) (1). [Apex of gonocoxite relatively simple, without subapical plate-like carinae.] This is an autapomorphy of *Mystacanthophora*.

53. Apex of gonocoxite flattened and hooked ventrad (Figs. 14a, 14b) (1). [Apex of gonocoxite variously shaped, not flattened and hooked ventrad.] This apomorphy is unique to *Lophanthophora*.

54. Apex of gonocoxite darkly sclerotized, distinctly demarcated from moderately sclerotized base of gonocoxite (Fig. 24f) (1). [Apex of gonocoxite concolorous with base of gonocoxite.] This apomorphy, found in *Anthophoroides,* does not occur in other anthophorids.

55. Gonobase small, in profile much wider than long (Fig. 28e) (1). [Gonobase large, in profile at

least half as long as wide (Figs. 19b, 30i).] All habropodine and eucerine bees have large gonobases. The gonobase has presumably become apomorphically reduced in various anthophorine groups.

56. Female constructs turret of mud over nest entrance (1). [Female leaves nest entrance unmodified, without turret.] Even though the old literature gives the reader the impression that most *Anthophora* build turrets, they are actually unique to *Melea*.

57. Stinging behavior absent (1). [Stinging behavior present (1).] An obvious apomorphy of *Melea*.

58. Batesian and/or Müllerian mimicry of bumblebees (1). [No apparent mimicry of bumblebees.] Another autapomorphy of *Melea*.

59. Nest constructed in wood (1). [Nest constructed in earth.] Only *Clisodon* nests in wood, with the possible exception of *Anthophora (Anthophoroides) signata*. Since all melitomine, eucerine and habropodine bees nest in the soil, soil nesting presumably is primitive.

60. Gonostylus fused to gonocoxite (1). [Gonostylus articulated with gonocoxite.] Melitomines, eucerines and habropodines all have articulated gonostyli. Presumably the fusion of the gonostylus to the apex of the gonocoxite is an apomorphy found in anthophorine as well as centridine bees (except *Caenonomada*).

61. Bridge of penis valves basally elongated and often emarginate (1). [Bridge of penis valves triangular, basally simple and either square or bluntly pointed.] All Anthophorinae have the plesiomorphic type of bridge of penis valves except the Anthophorini which have the bridge of the penis valves elongated to varying degrees.

62. First recurrent vein of forewing meeting posterior margin of second submarginal cell near its midpoint (1). [First recurrent vein meeting or nearly so with first transverse cubital vein.] Melitomine, eucerine and habropodine bees have the first recurrent vein of the forewing meeting or nearly so with first transverse cubital. Anthophorines have the apomorphic state.

63. Third submarginal cell of nearly equal length on posterior and anterior margins (1). [Anterior margin of third submarginal cell about half length of posterior margin.] All bees in the outgroup have a third submarginal cell which is narrowed anteriorly. All Anthophorini have the apomorphy.

64. S6 of male strongly convex, apically entire, apical margin strongly bent ventrad (1). [S6 of male gently convex, often apically emarginate, apical margin not or only slightly bent ventrad.] The S6 of male centridine and habropodine bees (except pachymelines) is strongly convex, apically bent ventrad and curving only on the lateral margins (few *Anthophora* have the apical margin bent ventrad but the disc is not strongly convex).

65. One gonostylus on gonocoxite of male (1). [Two gonostyli on gonocoxite of male.] All bees in the outgroup have two gonostyli per gonocoxite. One has apparently been lost in the Anthophorini.

66. Gonostyli much flattened and wide, paddle shaped (1). [Gonostyli elongate, usually slightly clubbed or only slightly flattened.] Melitomine, eucerine, centridine and anthophorine bees all have the elongate gonostyli if present. The flattened, paddle shaped, ventral gonostylus is unique to the Habropodini.

67. Stipes with apical concavity, housing the stipital comb, one-fourth length of stipes (1). [Stipes with long apical concavity housing stipital comb, broadly and shallowly emarginate, extending at least one-third length of stipes.] Among the non-parasitic Anthophorinae only the Habropodini and the Anthophorini have a short round notch housing the stipital comb. This is a strong synapomorphy uniting these two tribes.

68. Forewing apically papillate, papillae simple, not tipped with hairs (1). [Forewing apically hairy or if papillate, then papillae tipped with hairs.] Most bees have hairy wings. In Anthophorinae the hairs on the papillae have been lost twice, once in the Centridini *(Centris)* and again in the habropodine-anthophorine lineage.

69. Tibial scopa consisting largely of simple hairs on outer surface (1). [Tibial scopa consisting largely of plumose hairs on outer surface.] Almost all non-parasitic female Anthophorinae have the tibial scopa consisting mostly of plumose hairs, except the Habropodini and Anthophorini in which the scopal hairs are largely simple, sometimes with some plumose hairs along the anterior and posterior margins.

70. Jugal lobe of hind wing one-third or less length of vannal lobe measured from wing base (1). [Jugal lobe of hind wing at least one-half length of vannal lobe.] All Anthophorinae except the Habropodini and Anthophorini have relatively long jugal lobe one-half to three-fourths the length of the associated vannal lobes. (Large species of *Pachymelus* have the jugal lobe nearing one-half the length of the respective vannal lobe.) The shortening of the jugal lobe must be an apomorphy.

TABLE 2. MATRIX OF CHARACTERS LISTED IN TABLE 1.

Variables 1-59 are represented by the columns from left to right and concern *Amegilla* and the subgenera of *Anthophora*. Similarly variables 60-70 concern the tribal characters for Anthophorini and Habropodini. Variables which are not constant (i.e., 0 and 1 within the taxon) are indicated by P; the 0 was used in the cladistic analysis.

Variables	11111111112222222222333333333344444444445555555555
	12345678901234567890123456789012345678901234567890123456789
Amegilla	10201000000000110000000000000000000000000010101000000000000
Anthophora	10000000001000010001000P1100100000000001000000010010000000000
Lophanthophora	20000000000000001000PP1000000000011001000000P0P100001000000
Pyganthophora	2P000000000000001000PPP00000000010P01000P00010P100010000000
Petalosternon	10000010000000001000000000000000P0000100001000P00P00000000000
Clisodon	00000010001000001000000011100000001010000000110100000000001
Dasymegilla	0P000010100000001000000000000000000011010011010010000001000
Caranthophora	01200000000000001001010101000011000010001000101010000010000
Heliophila	PPPP00PP0P0000001P0000000P1P00000PP0P00PP0P0101PP00000P0000
Melea	00000000000000001010000101101000000010000010101010000011110
Anthophoroides	0P000000000000001010000101000101000010000010101010000100000
Rhinomegilla	10000000200001001000000001100000000000000010101011000010000
Anthomegilla	10000010200010001000000001100000000000000011201010100010000
Paramegilla	1P000000000000001000000P0000000P0100100000101OP1P0000000000
Mystacanthophora	01000100000000001000000001000000000001000P000P0P100010000000
	66666666667
	01234567890
ANTHOPHORINI	11110101111
HABROPODINI	00001011111

TABLE 3. LIST OF VARIABLES OF THE SUBGENERA OF *AMEGILLA*.

The explanation is as for Table 1.

1. Galea long, attaining in repose middle of midcoxa to surpassing slightly hind coxa (2). Galea attaining in repose only middle of midcoxa (1). [Galea only rarely attaining anterior edge of midcoxa.] Presumably tongues have elongated either in adapting to or coevolving with flowers which now have long nectar spurs or deep tubular corollas. The greatest tongue length has been achieved in *Glossamegilla* in which glossal length often exceeds 2 cm. Long tongues of this kind are not found in habropodine (except *Elaphropoda*) and eucerine bees, and are apomorphic.

2. Maxillary palpus with 4 segments (2). Maxillary palpus with 5 segments (1). [Maxillary palpus with 6 segments.] The 4-segmented maxillary palpus of *Notomegilla* appears to have evolved from a 5-segmented ancestral form since one species of *Notomegilla, A. chlorocyanea,* has 5 segments and *Notomegilla* is closely related to *Asaropoda* which has 5-segmented maxillary palpi. The loss of segments from a 6-segmented maxillary palpus, common to most bees, is an obvious apomorphy.

3. Female with pale paraocular marks (1). [Female without paraocular marks (1).] No habropodine or eucerine females have paraocular marks. Therefore, the presence of these marks presumably is an apomorphy.

4. S4 of male modified, apical margin bent ventrad (Fig. 39a) (1). [S4 of male normal, apical margin flat.] No habropodine, centridine or eucerine bees have a similarly modified S4. In *Amegilla* this character is found only in *Asaropoda*.

5. S5 of male modified, apical margin broadly and deeply emarginate (Figs. 37e, 39a) (1). [S5 of male normal, apical margin entire.] Most male bees in the outgroup have unmodified, entire apical margins of the S5. The apomorphy is unique to *Zonamegilla* and *Asaropoda*.

6. S5 of male with a dense patch of hair laterally (Fig. 37e) (1). [S5 of male with pubescence of disc distributed more or less evenly, no dense patch of hair near lateral margin.] The autapomorphy is found in *Zonamegilla*.

7. S6 of male with medioapical margin strongly convex (Figs. 37e, 39a) (1). [S6 of male with medioapical margin flat like lateral apical margin.] The apomorphy is unique to *Zonamegilla* and *Asaropoda*.

8. A large lateral tooth near end of apodeme of male S7 (Fig. 38d) (1). [Apodeme of S7 of male simple, lateral margins more or less parallel.] This tooth is found only in *Notomegilla.*

9. Lateral margin of S7 of male with a tooth on basal half (Fig. 36h) (1). [Lateral margin of S7 of male without a tooth on basal half.] The Habropodini lack this structure but some groups of *Amegilla* and *Anthophora* have it.

10. S7 of male with width of disc on basal two-thirds equal to about half of width of disc on apical third; basal two-thirds almost parallel-sided (Fig. 35h) (1). [S7 of male with width of disc varying on basal two-thirds such that basal two-thirds is not parallel-sided.] Eucerini, Habropodini and *Anthophora* do not have S7 with a long parallel-sided disc which is slightly expanded on apical third. Such a structure is presumably an apomorphy.

11. S8 of male with two well developed basal processes (Fig. 38c) (1). [S8 of male simple, without any basal processes.] This is an autapomorphy of *Notomegilla.*

12. Median apical lobes and lateral lobes protruding from apex of S8, with margin between them strongly emarginate (Fig. 37i) (1). [Median apical lobes weakly developed or lateral lobes absent; margin between them only weakly emarginate to entire.] This structure is only found in *Micramegilla.*

13. S8 of male apically narrowed, lateral margins converging apically (Fig. 37c) (1). [S8 of male apically broad, lateral margins more or less parallel (Fig. 36c).] Almost all males in the outgroup have broad eighth sterna. The apical tapering of this sternum is presumably an apomorphy.

14. Gonobase in lateral view much longer than wide (Fig. 36g) (1). [Gonobase in lateral view about as long as wide to wider than long.] This apomorphy is only found in *Ackmonopsis.*

15. Gonostylus greatly reduced to only a membranous blister or absent on gonocoxite (1). [Gonostylus present, from 3 to 10 times as long as wide.] The absence of a gonostylus is an apomorphy since all bees in the outgroup have gonostyli.

16. Penis valve with strong laterally protruding lobe on apical half (Fig. 36f) (1). [Penis valve with small lobe or no lobe laterally on apical half. This character is unique to *Megamegilla.*]

17. Pubescence metallic (1). [Pubescence not metallic.] None of the non-parasitic bees in the outgroup have metallic hair.

TABLE 4. MATRIX OF CHARACTERS OF THE SUBGENERA OF *AMEGILLA* LISTED IN TABLE 3.

Variables 1-17 are represented by the columns from left to right. Explanation as for Table 2 except P = 1 & 2.

	11111111
	12345678901234567
Anthophora	00000000000000000
Amegilla s. str.	00000000110010100
Zebramegilla	00100000010010100
Micramegilla	00100000100100100
Ackmonopsis	00000000100001100
Megamegilla	11000000000000010
Aframegilla	20000000100000001
Dizonamegilla	10100000000010100
Notomegilla	0P100001101010101
Zonamegilla	20101110100010101
Asaropoda	01011010100010000

CLADISTIC RELATIONSHIPS

The relationships of the Anthophorini-Habropodini to other Anthophorinae are not clear. Michener (1974) placed the Anthophorini (which included Habropodini) between Centridini and Eucerini, positioning the centridines (and the ericrocine-rhathymines) at the "terminus" of the Anthophorinae. This placement seems unjustified now that *Caenonomada* has been reassigned from the Exomalopsini to the Centridini (Snelling and Brooks, 1985). The many plesiomorphies of *Caenonomada* indicate a more ancestral position for the Centridini, possibly near the exomalopsines. If this is correct then the venational apomorphies hitherto used to associate the Anthophorini-Habropodini with the Centridini (i.e., shortening of the second abscissa of M + Cu, loss of hairs on the alar papillae and shortening of the marginal cell) are convergent between the more derived members of Centridini (i.e., *Centris* and *Ptilotopus*) and the Anthophorini-Habropodini. These wing attributes may be associated with large size or rapid flight. Probably the closest relative of the Anthophorini-Habropodini lineage is the Eucerini, the two groups at least sharing a small stigma. The former has diversified and probably arose in the Old World, the latter diversified and most likely originated in the New World.

In the following paragraphs, character numbers in parentheses are from Table 1 except as otherwise indicated.

Because of a strong apomorphy of *Amegilla* (i.e., loss of the arolia), one might suspect that it arose from *Anthophora,* which would thus be paraphyletic. Apparently, however, *Anthophora* is not paraphyletic, but is the sister group of *Amegilla.* The emarginate S6 of the male (37) is a weak apomorphy for *Anthophora* since a few species of *Amegilla* also have an emarginate S6. What lends support to the monophyly (*sensu* Hennig) of *Antho-*

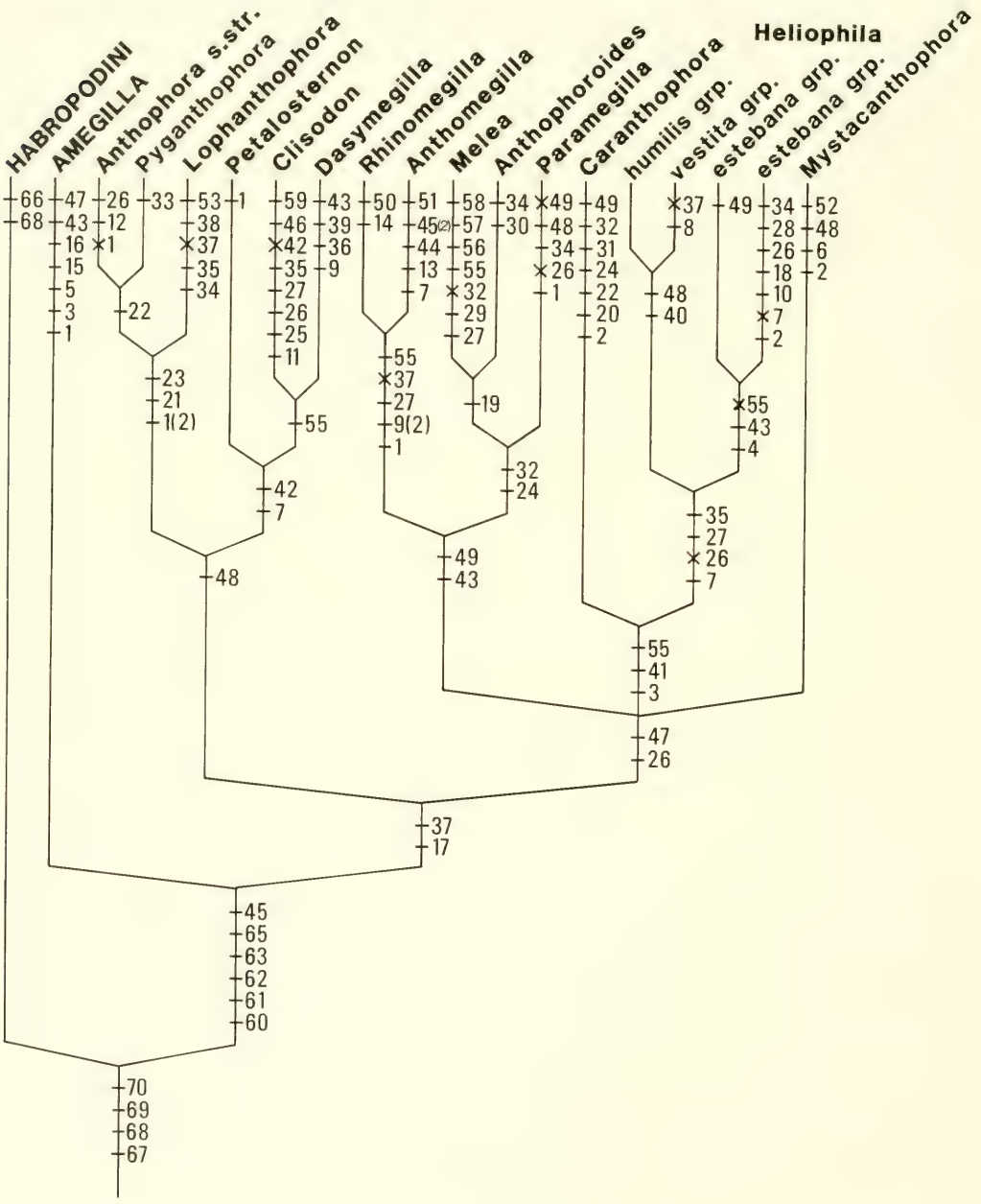

FIG. 40. Cladogram for the genera of Anthophorini and subgenera of *Anthophora.* The numbers represent apomorphies listed in Table 1. Numbers in parentheses represent further derived characters of a variable. An X indicates a reversion.

phora is the bilobed basistipital process (17), which is unique in the Anthophorinae. Even ignoring these characters, I can find no subgeneric group of *Anthophora* from which *Amegilla* might have evolved.

There are four main lineages of *Anthophora* shown in the cladogram (Fig. 40). The first is a group consisting of *Anthophora* s. str., *Pyganthophora* and *Lophanthophora* characterized by long first flagellomeres (1) and males which often have "brushes" of hair on their midlegs (21-23). The second group, consisting of *Petalosternon, Clisodon* and *Dasymegilla,* has males with a trilobed labrum (7) and S7 with a strong lateral tooth on the apodeme (42). The third and most "derived" group contains *Rhinomegilla, Anthomegilla, Melea, Anthophoroides,* and *Paramegilla.* Their male synapomorphies include an apically narrowed S8 (43) and an elongate, basally emarginate bridge of penis valves (49). The fourth group is *Caranthophora,* and *Heliophila.* The females of this group have white to yellow facial markings (3), males have short apodemes on S7 (41) and most have a small gonobase (55).

Figure 41 is an alternate cladogram which gives separate origins for the *Rhinomegilla-Anthomegilla* and *Paramegilla* groups, mainly because the former has males with simple hind legs (24). In addition the *Melea-Anthophoroides* group is shown as the sister group to *Heliophila* because they share a small gonobase which would have to be reversed in the Estebana species group of *Heliophila* (55). I prefer the cladogram in Figure 40 since it appears that *Rhinomegilla* and *Anthomegilla* have their closest relatives among *Melea, Anthophoroides* and *Paramegilla* as suggested by their similar terminalia. The unmodified hind legs (24, 32) of the *Rhinomegilla-Anthomegilla* group probably indicate that it is more ancestral than the *Melea-Anthophoroides-Paramegilla* group. Even though both cladograms are about the same length, the alternate one has five more reversals than the preferred one.

There are two main groups of *Amegilla* (Fig. 42). Six subgenera have S8 in males narrow apically (13, Table 3) and triangular. In the other five this sternum is broad apically and quadrate. The small number of characters used in the analysis of *Amegilla* reflects the homogeneity of this group, and results in a cladistic pattern that might change if additional characters are discovered.

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Unfortunately we have only two fossil records for *"Anthophora."* Cockerell described *A. melfordi* (1908) from Florissant, Colorado. There is no reason to differ with Cockerell's placement of this Oligocene fossil but not all of the diagnostic wing veins are clear (for further discussion see Zeuner and Manning, 1976). The placement is therefore speculative. The single specimen of *"Antho-*

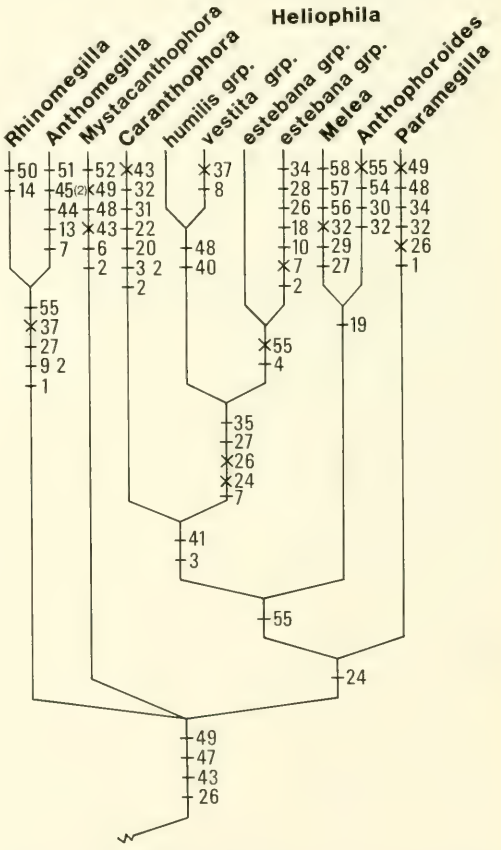

FIG. 41. Alternate cladogram shown for certain subgenera of *Anthophora,* using the same characters as for Fig. 40 but making different assumptions in the main right branch of the cladogram about which characters are convergent. Explanation as for Fig. 40.

phora effosa'' (Heyden, 1862) from Rott, West Germany (Oligocene) also cannot be placed with any certainty in *Anthophora* (Zeuner and Manning, 1976). Thus, this biogeographical discussion has to be based on present distribution and presumed phylogeny.

The greatest diversity of anthophorine species and subgenera occurs in the Mediterranean region which is the tribe's possible place of origin. Of the 14 subgenera of *Anthophora,* eight occur in the New World, of which seven are also Palearctic and only one limited to North America. It is therefore probable that the genus originated in the Old World. The genus *Anthophora* is widespread but conspicuously absent from the Indomalaysian-Australian area. Its absence there is probably due to its being ill-adapted to moist tropical climates through which it would have had to pass, given the present continental arrangement, to reach the temperate parts of Australia. Where it has penetrated the tropics, as in Africa and South America, *Anthophora* is found in montane or xeric habitats. *Anthophora* is apparently a good insular colonizer; it is found in the Cape Verde Islands, Canary Islands, numerous Mediterranean islands as well as the Greater and Lesser Antilles.

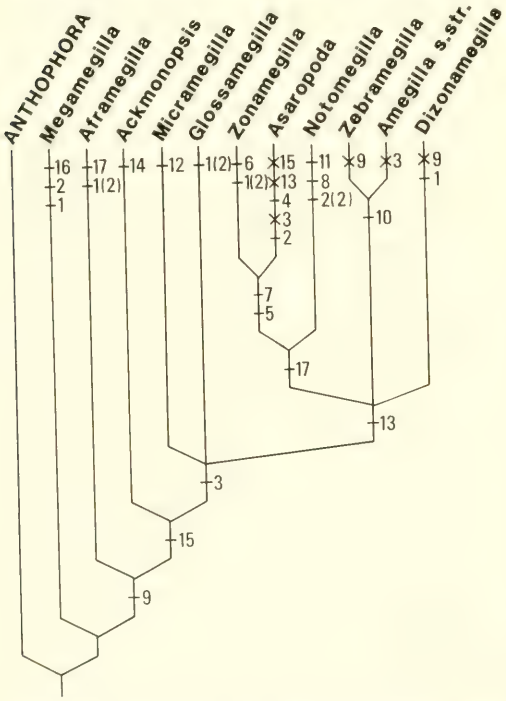

FIG. 42. Cladogram for the subgenera of *Amegilla.* Explanation as for Fig. 40. The apomorphies of the genera *Amegilla* and its sister group, *Anthophora,* are given in Fig. 40.

I recognize five lineages of *Anthophora.* The *Anthophora* group (*Anthophora* s. str., *Pyganthophora* and *Lophanthophora*), the *Clisodon* group (*Clisodon, Dasymegilla* and *Petalosternon*), the *Melea* group (*Melea, Anthophoroides, Paramegilla, Anthomegilla* and *Rhinomegilla*), the *Heliophila* group (*Heliophila* and *Caranthophora*) and the *Mystacanthophora* group *(Mystacanthophora).*

The *Anthophora* group has a disjunct temperate, but in terms of species diversity, a primarily Mediterranean distribution. *Anthophora* s. str. is restricted to the Old World. From its possible Mediterranean origin (seven species), where it is widespread and the species have the most plesiomorphies, it may have dispersed to East Asia (three species). *Pyganthophora* has a more disjunct distribution and is much more speciose than its sister group *Anthophora* s. str. in the Mediterranean region. *Pyganthophora* probably had its origin in the Mediterranean area where it includes at least 39 species many of which are the most ''primitive'' in the group. This subgenus probably was more widespread in the past than it is now because five species are isolated in South Africa and three in northeast China (Beijing area). Possibly there were two introductions of *Pyganthophora* to the New World; the Bering Strait is the most likely route since *Pyganthophora* in the New World is more or less restricted to the western United States. The North Atlantic route, when North America and Europe were much closer, seems less likely. It seems equally unlikely that vicariance explains the distribution of *Pyganthophora.* Of the six species in the New World, three belong to the endemic Crotchii species group and three to the mainly Old World Retusa species group. The New World members of the Retusa species group are typical members, that is, there is nothing in their morphology that sets them apart from the Old World ones. The Crotchii species group, however, is morphologically distinctive. The two species groups are sympatric over only about half of their

ranges in North America. *Lophanthophora* may well have had the same evolutionary past since it has a similar distribution to that of *Pyganthophora,* but lacks any South African members and has a widespread range in both western and eastern United States. Again like *Pyganthophora* it does not range into boreal regions and the New World members are not morphologically distinctive, as a group, from Old World members.

The *Clisodon* group is mainly temperate Palearctic. The most widespread subgenus, *Clisodon,* has only two or three species. One species is Holarctic (Popov, 1951) and inhabits part of northeastern China as well as northern North America. The other one or two species are Palearctic. Vicariance is an unlikely explanation of *Clisodon*'s range, since one species is boreal, occurring well into Alaska, and thence to northeastern China. Most likely this species also occurs in the intervening areas of Siberia. Since the other members of the *Clisodon* group are strictly Palearctic, presumably that is its area of origin. *Petalosternon* possibly originated in the Mediterranean region since 18 of its 21 species occur there.

The *Melea* group includes five subgenera with diverse distributions. *Rhinomegilla* and *Anthomegilla* both occur at high elevations in Asia, mainly in Xizang Province, China (Tibet) and in neighboring areas. *Rhinomegilla* is restricted to Xizang Province and Sikkim. *Anthomegilla* additionally occurs in Mongolia and the forest zone of Siberia. *Paramegilla* is widely distributed in the western Palearctic and Ethiopian regions. In addition, it has two species in the southwestern United States. This distribution may be explained by vicariance, or by former wider distribution. Neither the Old nor New World species are boreal and the two New World species are similar to their Old World counterparts, not unique as a subgroup in any morphological aspect. *Paramegilla* has great species diversity from the Mediterranean region east to the Aral Sea (at least 40 species). In the Ethiopian faunal region a single derived species group (about 10 species) of *Paramegilla* predominates. It seems clear that the area of origin for *Paramegilla* was in the Palearctic. *Anthophoroides* is found only in western North America, south to Honduras. There are 12 species (including six undescribed ones) which are mostly limited to the Mojave and Colorado Deserts. Two species have apparently dispersed to the south, one reaching Jalisco, México and the other Honduras. Since *Anthophoroides* is strictly New World and is the sister group of *Melea,* both may well have originated in the North America. Indeed, of the two species groups of *Melea,* the one with the most ancestral characters is the Bomboides species group, which has three nearctic and one palearctic species.

Of the *Heliophila* group, the member with the most ancestral characters is *Caranthophora.* It is Palearctic with two disjunct areas, one Mediterranean and the other Asian. The Vestita species group of *Heliophila* is subsaharan and has its center of species diversity and probable origin in southern Africa where the most primitive members of *Heliophila* are found. Therefore *Heliophila* probably had its origin in Africa. The Estebana species group is largely restricted to the southwestern United States, but ranges to Honduras. (A single specimen in the Berlin Museum is labelled Guayaquil, Ecuador, perhaps in error.) Southern California and Arizona is the center of species diversity of the Estebana species group (26 species plus one undescribed). Since one if not all of the species ranging into the neotropics also occur in the southwestern United States, they probably dispersed southward from a possible temperate origin.

Mystacanthophora occurs in several disjunct areas. Its largest, more or less continuous range is in North America where one species of the Urbana species group and three species of the Montana species group live. A monophyletic subgroup of the Montana species group is Antillean. The five Antillean species are more closely related to two American species than to the other neotropical members (seven plus one or two undescribed species). This suggests that *Mystacanthophora* invaded the Antilles from Florida. The possible invasion route via the Yucatán peninsula is also less likely because the single Mexican species is more closely related to

the South American species than to the North American and Antillean ones. Almost certainly the Antilles did not receive migrants directly from South America. Since *Anthophora* has proven to be able to cross substantial water barriers, dispersion rather than vicariance seems to explain the New World distributions. Antillean butterflies share a similar history (Brown, 1978).

There is a large gap in the range of *Mystacanthophora* in Central America. South American species mostly are found at high altitudes in the Andean zone and the northern half of Argentina to southeastern Brasil. Across another large gap, two species occur in the Old World, one in Iran and the other from Central Europe to Siberia. Since the most "primitive" species of *Mystacanthophora* is from the United States and the vast majority of species are in the New World, it seems reasonable to suppose that the group had a New World origin.

Unlike *Anthophora, Amegilla* has flourished in the Old World tropics, if one takes species diversity and abundance as a measure of success. The tropics are not barriers to its dispersal. *Amegilla* is also common in xeric areas such as the Mediterranean basin. Apparently it has little tolerance of low temperatures since it is not boreal or montane. Probably this intolerance of low temperatures explains its failure to reach the New World, since transoceanic routes are far northern. Obviously it has crossed moderate oceanic barriers to reach Australia from Asia, but it shows no evidence of having crossed major oceanic barriers.

Amegilla is a much more homogeneous genus than *Anthophora* and few good subgeneric synapomorphies are known. Perhaps its radiation is more recent than that of *Anthophora.* Putting aside the possibility of convergence, it seems that there have been two main lineages of *Amegilla,* (1) those with an apically wide, quadrate, male S8 (Fig. 36c) and (2) those with an apically narrow, triangular one (Fig. 35c). The first four basal subgenera of the *Amegilla* cladogram (Fig. 42) have mainly, if not totally, Ethiopian distributions. This may mean that *Amegilla* had an Ethiopian origin or that its relictual elements survive only in Africa and that representatives of these subgenera have gone extinct elsewhere. *Megamegilla,* the subgenus with the most plesiomorphies, is restricted to Africa, as are *Aframegilla* and *Ackmonopsis. Micramegilla* probably also originated there, since its closest relatives (i.e., *Megamegilla, Aframegilla* and *Ackmonopsis*) are Ethiopian, yet it dispersed into the Palearctic region. *Glossamegilla,* which is related to the last four subgenera as shown by the apically wide male S8, is mainly Oriental but also southeastern Palearctic.

The second group of subgenera, with an apically narrow male S8, is centered more in Australia and southeast Asia than the first group, except *Zebramegilla* and *Amegilla* s. str. which are more western. *Dizonamegilla* consists of three species, one in Somalia, one in India and one in Timor. *Zebramegilla,* the sister group to *Amegilla* s. str., is one of the most widespread subgenera. It occurs over most of Africa, the Mediterranean region, thence to South India and Sri Lanka. *Amegilla* s. str. is more restricted, occurring in eastern and northern Africa, the Mediterranean region and northern India. It is not unreasonable to suppose that both originated in the Ethiopian region since over 90% of their species occur there.

The three remaining subgenera occur wholly or partly in the Australian region. Of these, *Notomegilla* occurs only in Australia, penetrating the interior of the continent, unlike *Asaropoda* whose range is apparently everywhere in Australia except centrally and includes New Guinea and the Bismarck Archipelago. The New Guinean species of *Asaropoda* are similar to those of Australia and probably originated in that continent. *Zonamegilla,* the sister group to *Asaropoda,* is found throughout the Australian and Oriental regions and has slightly entered the Palearctic region. Most of the species of *Zonamegilla* occur in the Indomalaysian area. Since *Asaropoda* is confined to the Australian region it is possible that this was the area of origin for *Zonamegilla* also. On the other hand since Anthophorini are probably relatively recent arrivals in Australia, it is more likely that *Zonamegilla* or its immediate ancestor spread from Asia and gave rise to *Asaropoda* in Australia. Thus only one disper-

sal from Asia to Australia could account for the present Australian fauna.

Evidently major barriers to *Anthophora* dispersal have been oceans and lowland tropics. The only large southern hemisphere *Anthophora* fauna is in southern Africa which is accessible from the North via the east African highlands. Otherwise only one subgenus, *Mystacanthophora,* has crossed tropical regions; it is found in both North and South America and tropical species exist now in the Antilles. To account for the subgeneric dispersal in the northern hemisphere, *Anthophora* must have moved between eastern and western hemispheres at least six times. Most such dispersal was presumably in the North, probably across the Bering Strait area, for it involved subgenera that include species that range into cool to cold climates. The *Heliophila* case (Humilis and Estebana species groups) however, involves groups now restricted to warm and commonly arid regions. Vicariance across the Atlantic or more accurately dispersal across the Atlantic when it was much narrower than at present may well explain the present distribution of this subgenus. The presence of endemic *Anthophora* species on oceanic Atlantic islands shows the potential for dispersal across moderate ocean barriers.

The fact that the biogeography of Anthophorini can be largely, or wholly explained as dispersal, with little evidence of vicariance through continental movement, suggests that this is a group most of whose evolution occurred after the continents had more or less attained their present positions.

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APPENDIX 1. NEW SPECIES OF ANTHOPHORINI

Although many new species of Anthophorini exist, I describe only a few here. They are species of special interest because of morphology or distribution, and are therefore referred to in the subgeneric accounts. Type depositories of new species are indicated in brackets (see Methods).

Anthophora (Mystacanthophora) boharti new species

Diagnosis. Hair Chamois, clypeus protuberant only half width of eye in profile, female face not modified as in most other *Mystacanthophora;* male with metasoma modified, S6 broadly emarginate, S5 apically entire but basal half with thick pile of white hair (Fig. 44f); S7, S8, and genital capsule as in Figures 43a-d.

Description. Male: Length 14.4 mm; forewing

length 9.1 mm. *Structure.* Inner orbits diverging above; shortest distance between eyes .7 frontal length of eye; malar space short; head wider than long; clypeus protuberant, half eye width; labrum apically simple; flagellomere 1 equal to combined length of next two flagellomeres, two-thirds as long as scape (excluding basal bulb) and twice as long as flagellomere 2; flagellomere 2 three-

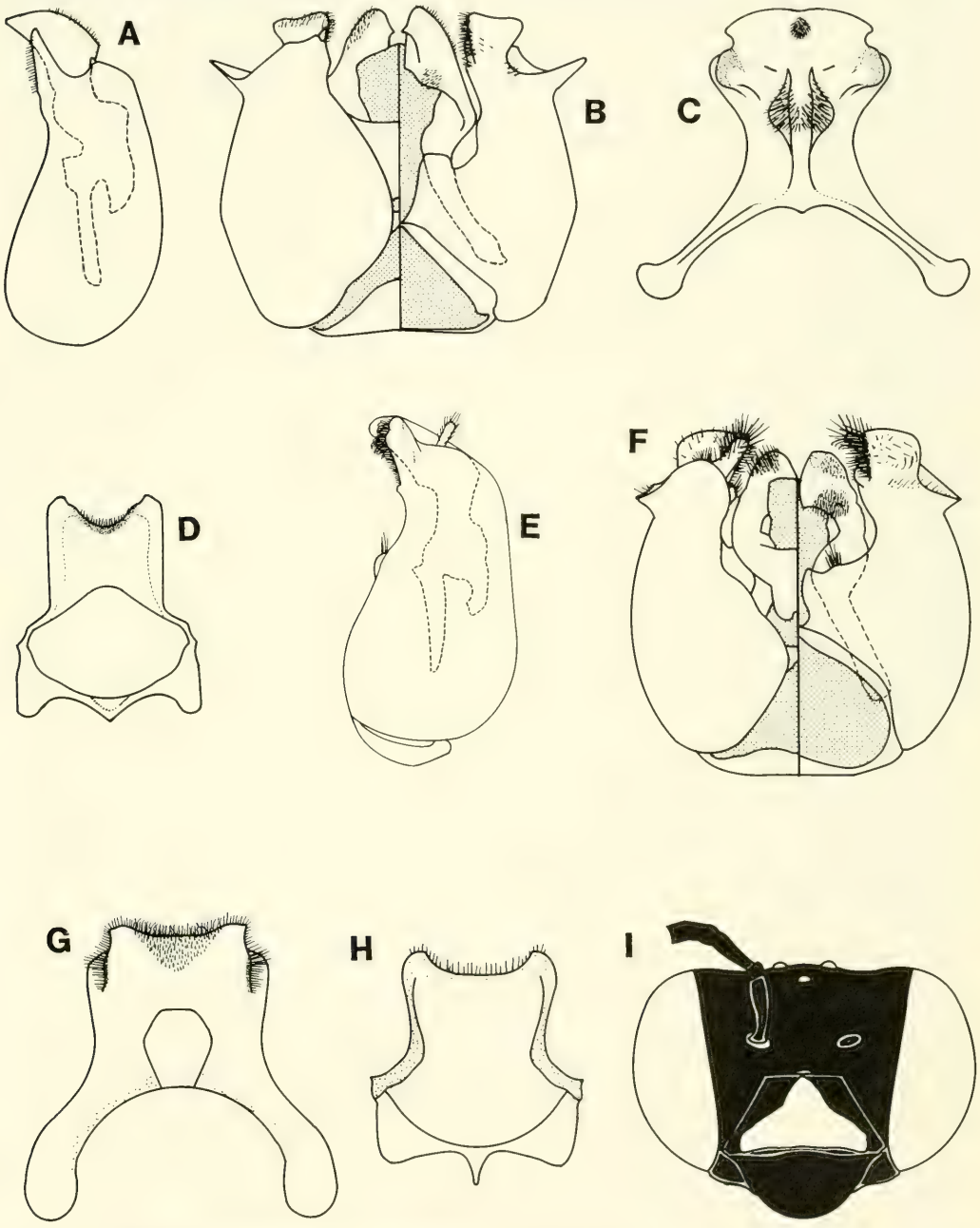


FIG. 43. New species of *Anthophora (Mystacanthophora).* A-D, *A. (M.) boharti* male; E-H, male, I, female, *A. (M.) bahamensis.* A, B, Genital capsule, side and dorsoventral views. C, D, S7 and S8, ventral views. E, F, Genital capsule, side and dorsoventral views. G, H, S7 and S8, ventral views. I, Head of female (hair omitted).

fourths length of 3, 3-10 about equal in length; last flagellomere subequal in length to 1; distance between posterior ocelli about twice ocellocular distance; distance from median ocellus to posterior ocellus slightly shorter than ocellocular distance. S5 and S6 broadly emarginate, other sterna apically entire (Fig. 44f); S7 and S8 as in Figures 43c, d, S7 apically round, not broadly emarginate, lateral margin with two weakly developed lobes, apical margin with only submedian patch of dark setae and disc with large patch of dark setae inserted on raised, laterally carinate ridge; S6 without medioapical protuberance; S5 with a dense pad of white hair covering basal half of disc from gradulus distally (Fig. 44f); genital capsule as in Figures 43a, b. Second submarginal cell receiving first recurrent vein slightly distal to midpoint; cu-v of hind wing about .8 length of second abscissa of M + Cu; vein M 2.7 times as long as second abscissa of M + Cu; jugal lobe about one-third length of vannal lobe. Pygidial plate absent, apparent medioapical margin of T7 with two blunt lobes. *Coloration.* Brownish black, mouthparts (including basal half of mandible), veins, tegula, legs, and S1-S4 Burnt Sienna; labrum, clypeus, paraocular area up to insertion of scape, supraclypeal area, and scape anteriorly white; wings clear. *Pubescence.* Chamois, except for two black patches of hair on inner margin of hind leg, one on apex of trochanter, other at base of femur; apical margin of S5 with band of dark hair, thicker laterally and with thicker median patch; apical margin of S4 with pair of submedian patches of dark hair (Fig. 44f); pile of head and thorax about length of scape, propodeal area with longer hair about length of midtibia, hair of legs and metasoma short, about length of flagellomere 2 but longer on lateral edges of S3-S4; hair of terga more or less evenly covering visible surfaces but forming indistinct apical bands; S5 basally with thick pad of white hair (Fig. 44f), S2-3 basomedially with a thick patch of white hair. *Punctation.* Clypeus, paraocular and supraclypeal areas shiny, lacunose, ground between punctures smooth; labrum shiny, lacunose, ground between punctures weakly microareolate; upper half of face shiny, puncticulate, ground between punctures smooth; scutum dull but weakly shining at margins and pleura dull, microareolate; T1-T6 shiny, densely punctate with impunctate apical margins, ground between punctures weakly microareolate to smooth; S1-S3 with scattered punctures, S4-S6 with more densely spaced punctures, all sterna shiny with ground between punctures microareolate.

Female: Length 14.3 mm, forewing length 9.3 mm. Agrees with description of male except for sex-limited characters and as follows: *Structure.* Shortest distance between eyes .9 length of eye; flagellomere 1 equal to combined length of next three flagellomeres and .83 length of scape, flagellomeres 2-9 about equal in length, flagellomere 10 slightly longer than preceeding flagellomere. *Coloration.* Black except legs and sterna Burnt Sienna, sometimes with a small medioapical pale spot on clypeus. *Punctation.* Face shiny; clypeus and supraclypeal area rugulose-lacunose; labrum and paraocular area rugose; upper face puncticulate, all ground between punctures on face smooth to weakly microareolate; center of scutum shiny, impunctate, smooth, margins of scutum shiny, microareolate; pleura weakly shining; T1-T6 shiny, puncticulate, apical margins impunctate, ground between punctures smooth.

Type material. Holotype male and allotype female: Iran: Hamadan, 10 August, 1964, collected by George E. Bohart, the holotype on basil *(Ocimum basilicum).* Female paratypes were collected in Iran by Bohart at Cazemabar (one female, 9 August 1964) on *Medicago sativa,* at Drazan on *"Salvia"* (one female, 9 August 1964), and at the base of Damayand Mt. (2 females, 14 August 1964). The type series is deposited as follows: Male holotype and allotype [Washington], two female paratypes [Lawrence] and two female paratypes [Logan].

Comments. This species is one of two members of its subgenus that occur in the Old World. It can be separated from *A. borealis* by the much larger size (*borealis* is 10-11 mm), in the male by the large black area basolaterally on the clypeus and the patches of pale hair apically on S5 and S6. Additionally, *boharti* has essentially all hair pale on the head, thorax and metasoma; in *borealis* the pale hair there is intermixed with much black.

Etymology: This species is named after Dr. George E. Bohart, the collector. I gratefully acknowledge the generous loan of various species of the Estebana group of *Heliophila* and his comments on this group, which greatly facilitated this study.

Anthophora (Mystacanthophora) bahamensis new species

Diagnosis. Female with Marguerite Yellow integumental mark on clypeus (Fig. 43i); metasomal terga with apical Ochraceous Buff integumental bands of hair.

Description. Female: Length 11 mm; forewing length 8 mm. *Structure.* Inner orbits diverging above (Fig. 43i); shortest distance between eyes .8 length of eye; malar space short; head wider than long; clypeus relatively undeveloped, clypeus moderately protuberant, in profile .4 width of eye; flagellomere 1 equal to combined length of next 2.8 flagellomeres, .6 as long as scape (excluding basal bulb) and 1.4 times as long as last flagellomere, flagellomeres 2-9 about equal in length and as long as wide; distance between posterior ocelli about equal to ocellocular distance, distance of median ocellus to posterior ocellus half ocellocular distance; second submarginal cell receiving first recurrent vein slightly distal to midpoint; cu-v of hind wing equal in length to second abscissa of M + Cu; vein M 4.3

times as long as second abscissa of M + Cu; jugal lobe about one-third length of vannal lobe. *Coloration.* Brownish black except mouth-parts (including basal two-thirds of mandible), legs, veins, and metasomal sterna reddish brown; clypeus with pale integumental mark (Fig. 43i); wings clear. *Pubescence.* Ochraceous Buff, except paler on face, pleura and thoracic sterna; a few dark hairs near posterior ocelli, center of scutum, on visible portions of T2-T6, and dense around pygidial plate; pile on head, thorax (except propodeal area where length is slightly longer), T1 and sterna about equal in length to scape and erect, posteriorly inclined; hair on T2-T6 shorter than scape; apical bands of hair on terga absent. *Punctation.* Face dull; clypeal, paraocular and supraclypeal areas lacunose, ground between punctures strongly microareolate; labrum rugose, ground between rugae shiny, smooth; upper face somewhat shining, punctulate, ground between punctures microareolate; scutum and pleura dull, finely microareolate; propodeal area weakly shining, with scattered punctures, ground between punctures microareolate; T1-T4 dull, puncticulate but apical margin impunctate, width of impunctate margin becoming wider from T1-T4, ground between punctures microareolate, T5-T6 punctate, punctures almost confluent to 1 puncture-width apart, ground between punctures microareolate; S1-S6 shiny, with scattered punctures becoming more densely spaced from S1-S6, ground between punctures microareolate.

Male: Length 10.7 mm, forewing length 8 mm. Agrees with description of female except for sex-limited characters and as follows: *Structure and Pubescence.* Flagellomere 1 equal to combined length of next 1.6 flagellomeres together; hind leg simple, basitibial plate absent. Pygidial plate absent, apparent medioapical margin with two blunt lobes; S6 broadly emarginate apically with a medioapical protuberance and lateral depression; S5 apically entire with four patches of black hair, a smaller submedian pair and a larger patch lateral to submedial ones (Fig. 44g); basal two-thirds of disc from gradulus distally with a thick, dense pad of white hair; S4 apically entire; S7, S8 and genital capsule as in Figures 43e-h. *Coloration.* Basal third of mandible, labral, clypeal, paraocular and supraclypeal areas and scape anteriorly white. Punctation. Labrum shiny, lacunose, with ground between punctures smooth.

Type material. Holotype female: Bahama Islands, New Providence, Nassau, 28 June 1904, collected by Allen, Barbour, and Bryant [Cambridge]. Allotype male: Bahama Islands, Nassau, British Museum 1931-343, collected by G. Salt [London].

Etymology. This species is named for the Bahama Islands.

Comments. This species is closely related to *A. tricolor* (Fabricius) from which it is separated in the female by a pale mark on the clypeus and in the male by a pale mark on the mandible and the strong median, longitudinal rounded ridge on S6. The shape of S7, S8 and the genital capsule distinguish *A. bahamensis* from other Antillean *Anthophora.* The species is restricted so far as known to New Providence, Bahama Islands (*A. tricolor* does not occur there).

Anthophora (Anthophoroides) signata new species

Diagnosis. Female with white, integumental, inverted T-shaped mark on clypeus and triangular mark on labrum; male with greatly modified hind leg, tibia dilated with large anteroapical spine and basitarsus greatly flattened with large basoapical spine (Fig. 44e).

Description. Male: Length 10 mm; forewing length 7.4 mm. *Structure.* Inner orbits diverging above; shortest distance between eyes about equal to length of eye; head wider than long; clypeus protuberant, in profile about equal to eye width; flagellomere 1 equal to combined length of next 1.6 flagellomeres together, .52 as long as scape (excluding basal bulb), 1.6 times as long as flagellomere 2, and .92 times as long as last flagellomere, flagellomeres 2-10 about equal in length and about 1.6 times longer than wide; distance between posterior ocelli equal to 1.54 ocellocular distance; distance from median ocellus to posterior ocellus equal to .69 ocellocular distance, labrum with medioapical notch; hind leg modified (Fig. 44e), with femur and tibia dilated, bulbous, apex of tibia with large, anterior spine with outer tibial spur inserted on its apical third, hind basitarsus greatly flattened and with large blunt tooth and apicoanterior small acute tooth; base of inner hind tibial spur partially enclosed, enclosure forming a small, sharp tooth against spur; second submarginal cell receiving first recurrent vein slightly distal to midpoint; marginal cell length .67 distance from apex of cell to wing tip; hind wing with cu-v 1.2 times length of second abscissa of M + Cu; vein M 3.0 times as long as second abscissa of M + Cu; jugal lobe .4 length of vannal lobe; terminalia as in Figures 44a-d. *Coloration.* Black except apices of tarsomeres and claws ferruginous; basal half of mandible, labrum (except translucent basolateral spot), clypeus (except anterior tentorial pit), paraocular and supraclypeal areas, and scape anteriorly white; paraocular area extends from malar space to upper margin of antennal socket; wings clear, veins reddish black. *Pubescence.* Hair white except a few scattered black hairs on vertex; pronotal lobe, scutum, S2-S6, T5-T6 medioapically, T7 all white, and ferruginous hair on inner surfaces of tarsi. Length of hair on face, foretarsus, foretibia, hind femur, thorax, metasomal sterna and T1 slightly longer than length of scape, hair on midleg about length of scape or shorter, hair on forefemur and scopa long, about equal to length of hind tibial spur, hair on visible portions of T2-T5 shorter than length of scape and directed

posteriorly at a 45 degree angle; scutum visible through pile, T2-T6 with sparse scattered hair, without apical hair bands, T1 covered with hair, T7 with all pale hair. *Punctation.* Face weakly shining; clypeus, paraocular and supraclypeal areas lacunose, ground between punctures microareolate; labrum rugulose-lacunose, ground between punctures weakly microareolate; rest of face punctulate, ground between punctures smooth; center of scutum with scattered punctures, becoming more densely punctate to almost confluent toward margins, ground between punctures weakly microareolate; pleura dull, coarsely punctate with punctures separated by 0.5-1.0 puncture widths, ground between punctures microareolate; propodeal area shiny, with scattered punctures, ground between punctures microareolate; T1-T6 weakly shining, foveolate- punctiulate with punctures separated by 0.5-10.0 puncture-widths, except apical margins impunctate, ground between punctures microareolate, T7 more shiny, punctate with punctures sepa-

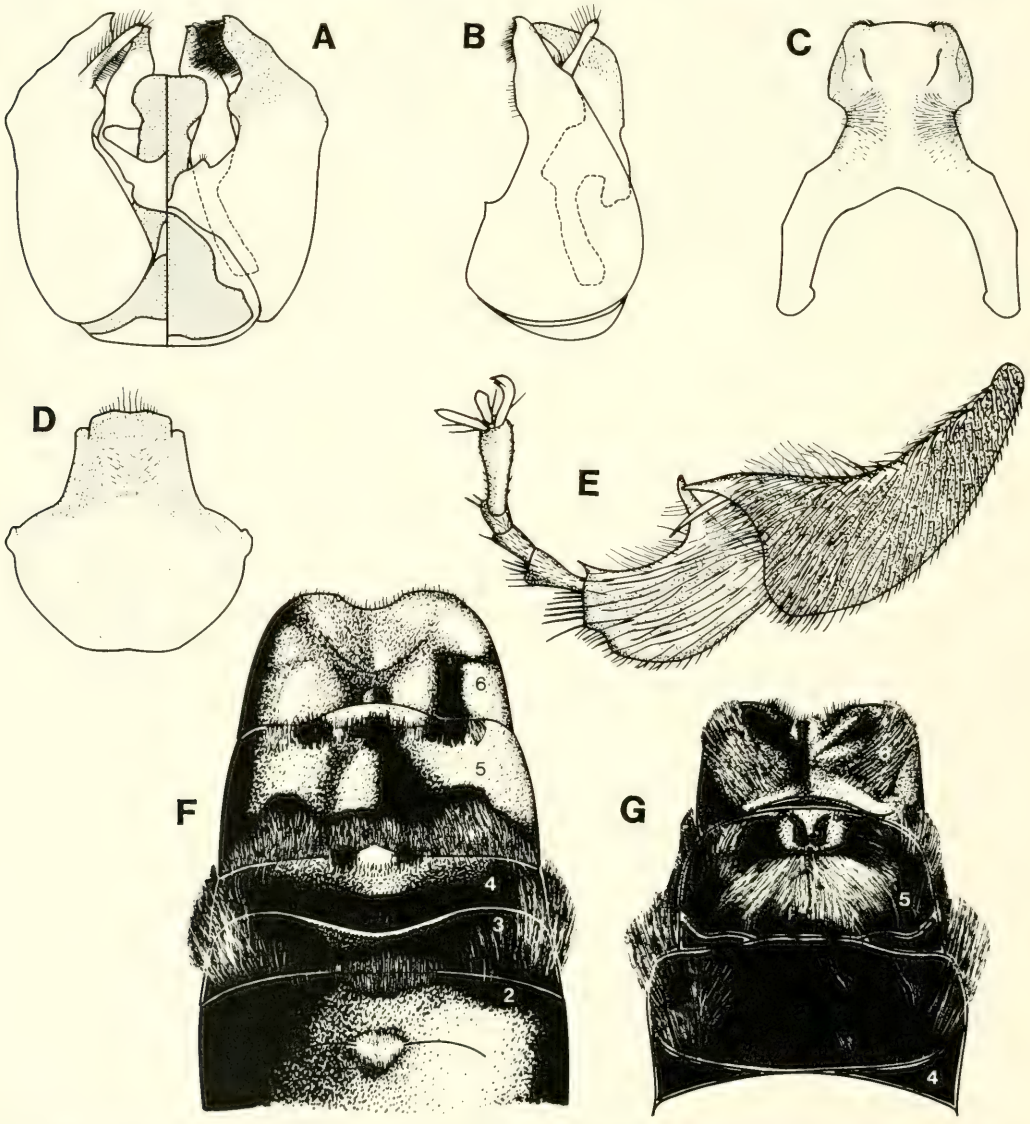


FIG. 44. New species of *Anthophora,* males. A-E, *A. (Anthophoroides) signata;* F, *A. (Mystacanthophora) boharti;* G, *A. (M.) bahamensis.* Numbers refer to the metasomal sterna. A, B, Genital capsule, dorsoventral and side views. C, D, S7 and S8, ventral views. E, Hind leg, outer view. F, S2-S6, ventral view. G, S4-S6, ventral view.

rated by 0.5-1.0 puncture-widths, ground between punctures smooth to weakly areolate; S1-3 with scattered punctures, S4-S6 with punctures becoming denser near apical margins, apical margins impunctate, ground between punctures microareolate.

Female: Length 10-11 mm; forewing length 7-8 mm. Agrees with male description except for sexlimited characters and as follows: *Structure.* Inner orbits diverging above; shortest distance between eyes about equal to length of eye; clypeus protuberant, in profile .75 eye width; flagellomere 1 equal to combined length of next 2.7 flagellomeres, .67 as long as scape (excluding basal bulb) and 1.4 times as long as last flagellomere, flagellomeres 2-9 about equal in length and slightly longer than wide; distance between posterior ocelli equal to 1.25 ocellocular distance, distance from median ocellus to posterior ocellus equal to .56 ocellocular distance. *Coloration.* Black except apices of tarsomeres and claws ferruginous; clypeus and labrum with white integumental marks, that of clypeus shaped like an inverted "T," of labrum triangular. *Pubescence.* T6 surrounded basally with black and laterally white. *Punctation.* Face shiny; clypeus with large punctures separated by 0.3-3.0 puncture widths, ground between punctures weakly microareolate; clypeus with median portion lacunose, laterally rugulose to more finely punctate at margin, ground between punctures near margin microareolate; rest of face foveolate, ground between punctures smooth.

Type material. Male holotype: California, Los Angeles Co., 2.5 mi. (4 km) S. Pearblossom, 3500 feet (1067 m), 14 May 1978, collected on *Salazaria mexicana* by R. W. Brooks; female allotype with same data [Lawrence]. Paratypes: CALIFORNIA: *Inyo Co:* Argus Mts., 1 female, 31 May 1940 (D. Meadows), 2 females, 4 June 1939 on *Penstemon* (R. Bohart); San Lucas Canyon, Inyo Mts., 5800 feet (1768 m), 2 males, 22 June 1978 (T. Griswold); Surprise Canyon, Panamint Mts., 4 males, 24 April 1957 on *Peucephyllum schottii* (J. Powell, P. Hurd), 1 male, 28 April 1953 (G. Marsh), 1 male, 9 May 1958 (L. Stange); Wild Rose Canyon, Panamint Mts., 1 male, 14 May 1969 (P. Opler). *Kern Co:* Last Chance Canyon, El Paso Mts., 2 males, 15 April 1964 (R. Snelling). *Los Angeles Co:* Desert Springs, 2 females, 5 May 1956 (J. Powell); Little Rock, 1 female, 22 April 1950 (C. MacNeil); Mojave Desert, Highway 138, 3600 feet (1097 m), 2 females, 28 April 1947 on *Salvia dorrii* (P. Timberlake); Palmdale, 1 male, 15 April 1956 on *Eriogonum* (R. Erdmann); 15 mi. (25 km) southeast Palmdale, San Gabriel Mts., 2 females, 22 April 1972 from burrows (D. Bixler); 2 mi. S. (3.2 km) Pearblossom, 3500 feet (1067 m), 1 male, 18 April 1977 (R. Snelling), 3 females, 1-2 May 1977 on *Salazaria mexicana* (R. Snelling); 2 females, 17 May 1977 on *Salazaria mexicana* (R. Snelling); 4 mi. (6.4 km) S. Pearblossom, 2 females and 3 males, 13-14 April 1960 on *Salvia* (R. Snelling); 5 mi. (8 km) S. Pearblossom, 1 male, 23 April 1956 on *Tamarix gallica* (E. Linsley); 6 mi. (10 km) SE. Pearblossom, 1 male, 16 March 1972 (R. Snelling). *Riverside Co:* Blythe, 1 male, 2 April 1941 (J. MacSwain, E. Linsley); Joshua Tree National Monument, Quail Springs, 1 male, 12 April 1950 (P. Hurd). *San Bernadino Co.,* 10 mi. (16.6 km) S. Adelanto, 1 female, 3 May 1939 (P. Timberlake); Apple Valley, 1 female, 8 May 1958 on *Gilia latiflora davyi* (P. Hurd), 1 female, 9 May 1958 on *Phacelia distans* (P. Timberlake), 1 female, 9 May 1955 (W. Richards); Hesperia, 1 female, 30 April 1939 on *Tetradymia axillaris* (P. Timberlake); Kramer Hills, 7 mi. (11.6 km) SE. Boron, 1 female, 14 April 1958 (J. Powell), 1 female, 10 May 1955 (W. Richards); Lucerne Valley, 1 female, 7 May 1938 (C. Dammers); Morongo Valley, 1 female, 18 April 1955 (W. Richards); San Bernadino Mts., 3800 feet (1158 m), 1 male, 15 May 1937 (E. Linsley); 7.5 mi. (12 km) S. Twentynine Palms, 1 female, 7 May 1948 on *Salazaria mexicana* (P. Timberlake); 3 mi. (5 km) SW. Victorville, 6 females, 6 May 1939 on *Dalea fremontii saundersii* (P. Timberlake), 2 females, 12 May 1939 on *Haplopappus cooperi* (E. Linsley). NEVADA: *Clark Co:* Charleston Mts., Lee Canyon, 2 females, 25 May 1940 (G. Bohart). Ten paratypes deposited at [Berkeley], 17 [Brooks], 1 [Lawrence], 5 [Logan], 13 [Los Angeles], 2 [Ottawa], 1 [Pullman], 12 [Riverside] and 1 [San Francisco].

Etymology: This species is named *signata* because of the white clypeal mark on the female.

Comments. Anthophora signata and the subgenus *Clisodon* are the only known species of *Anthophora* to nest in wood. At Pearblossom, California, the species nests in old Joshua tree stumps *(Yucca brevifolia)* (R. Snelling, personal comm.) but apparently also burrows in the ground (see data from 15 mi. SE. Palmdale). This species together with *A. bahamensis* (restricted to New Providence, Bahama Islands) are the only known New World *Anthophora* (except *Heliophila*) whose females have white integumental facial marks. *A. signata* can easily be separated from *bahamensis* since it does not have apical pale integumental bands on the metasoma. *A. signata* is most closely related to another undescribed species and *A. phaceliae* from which it can be separated by the unique shapes of S4-S8, the genital capsule and hind leg of the male (Figs. 44a-e). Especially noteworthy is the combination of characters of the male hind leg (Fig. 44e), that is the apical spine on the tibia is bidentate, the tibia is strongly dilated, the basitarsus greatly flattened with the long basal tooth wide, almost bidentate at apex.

Anthophora (Anthophoroides) phaceliae new species

Anthophora abruptella, Marston, 1964, p. 101 (misidentification).

Diagnosis. Head, upper third of thorax in female, all of thorax in male and first metasomal segment covered with ochraceous pubesence; rest of metasoma essentially black with only a few scattered pale hairs in male and all black in female. Shape of hind leg, S7 and S8 and genital capsule shown in Figs. 45a-e.

Description. Male: Length about 10-11 mm; forewing length about 7.7 mm. *Structure.* Inner orbits diverging above; shortest distance between eyes equal to .87 length of eye; head wider than long; clypeus protuberant, in profile .77 eye width; flagellomere 1 equal to the combined length of next 1.5 flagellomeres together, .54 as long as scape (excluding basal bulb) and about as long as last flagellomere, second flagellomere .54 length of flagellomere 1, flagellomeres 3-10 about equal in length, 1.50 times longer than wide, individual segments .83 length of flagellomere 1; distance between posterior ocelli 1.47 ocellocular distance, distance of median ocellus to posterior ocellus equal to .67 ocellocular distance; labrum with medioapical notch; hind leg modified (Fig. 45d); hind trochanter with inner posterior tooth; hind femur and tibia bulbous; hind tibial apex with long anterior spine bearing an apical and subapical acute projection; inner hind tibial spur as in *A. signata;* hind basitarsis longitudinally

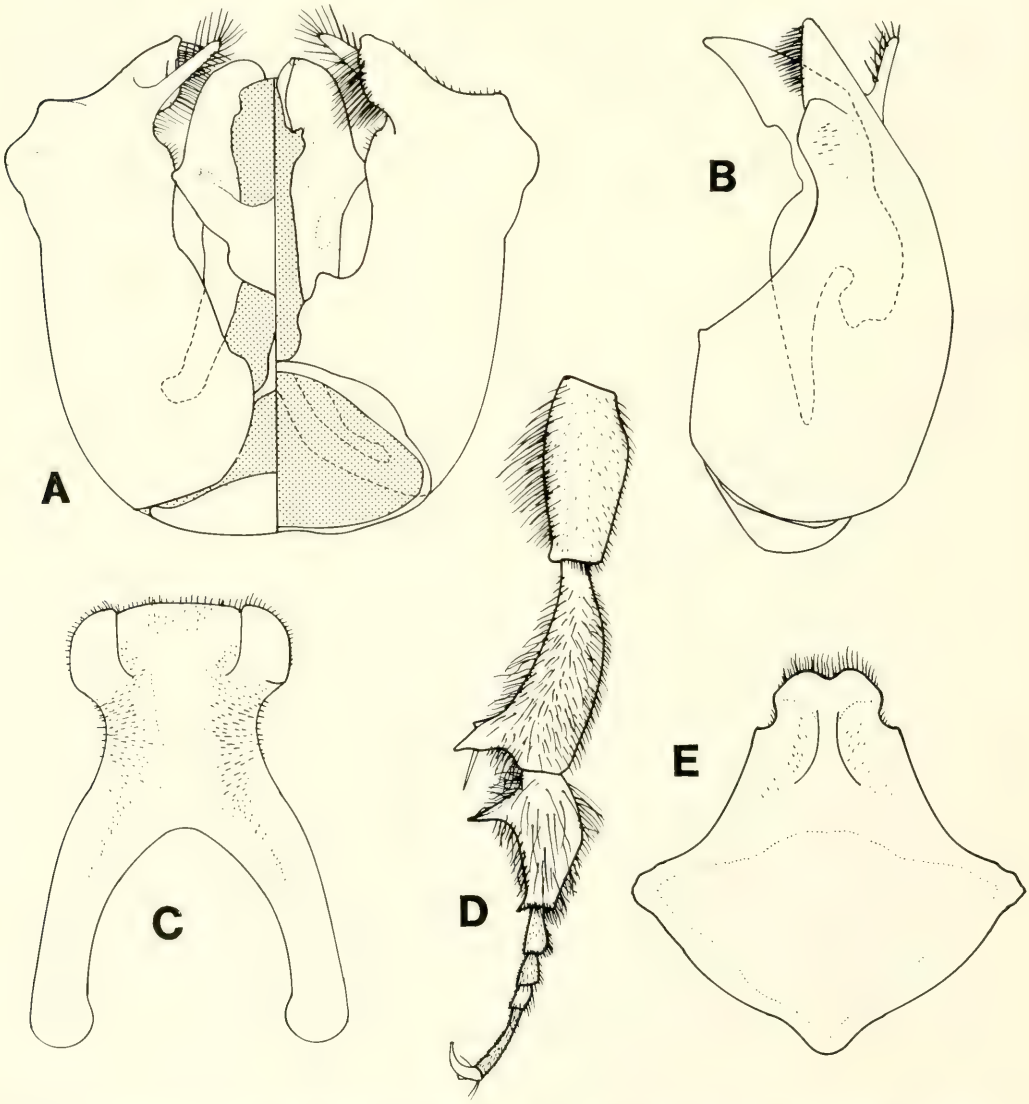


FIG. 45. *Anthophora (Anthophoroides) phaceliae,* male. A, B, Genital capsule, dorsoventral and side views. C, S7, ventral view. D, Outer view of hind leg of male. E, S8, ventral view.

concave on outer surface near posterior margin, anterior basal tooth widened at apex, blunt, and upper anterior surface concave; terminalia as in Figures 45a-c, e. Second submarginal cell receiving first recurrent vein slightly distal to midpoint; marginal cell length 0.80 distance from apex of cell to wing tip; hind wing with cu-v 0.77 times length of second abscissa of M + Cu; vein M 2.72 times as long as second abscissa of M + Cu; jugal lobe .4 length of vannal lobe. *Coloration.* Facial markings as in *A. signata* male. Black except basal half of tarsal claws ferruginous; tegula amber; wings clear, veins reddish brown; legs, S1, S2 and more or less S3 dark ferruginous. *Pubescence.* Hair pale except a few scattered dark hairs on supraclypeal area between antennae and vertex. Scutal pubescence dense, pale with a few scattered dark hairs; rest of thorax, fore and midtibiae all pale; pubescence of head and thorax about equal to length of scape; that of fore and midlegs all black except a pale patch on outer apices of tibiae; hind leg black except pale hair on outer surface of coxa, a pale patch on outer apices of hind femur and tibia; hind basitarsus with a few long pale hairs on outer surface, outer posterior edge of rest of tarsomeres with some pale hair. Metasoma with sparse erect black hair up to length of flagellomere 1; terga with a few pale hairs laterally, T4 and T5 with a sparse weak row of long pale hairs along basal edge of apical impunctate margin; medioapical margin of T7 with some pale hair. *Punctation.* Face as in *A. signata,* weakly shining. Thorax dull, punctation confluent, propodeal area weakly shining. Metasoma as in *A. signata* except terga weakly shining.

Female: Agrees with male description except for sex-limited characters and as follows: Length about 11 mm; forewing length about 8.6 mm. *Structure.* Clypeus protuberant, in profile .67 eye width; flagellomere 1 equal to slightly more than combined length of next three flagellomeres, .79 as long as scape (excluding basal bulb) and 1.59 times as long as last flagellomere, second flagellomere .31 length of flagellomere 1, flagellomeres 3-9 about equal in length, longer than wide, individual segments .37 length of flagellomere 1; distance between posterior ocelli 1.14 ocellocular distance, distance of median ocellus to posterior ocellus equal to .32 ocellocular distance. *Coloration.* Black except basal halves of tarsal claws ferruginous and tegula amber. *Pubescence.* Upper third of pleura and propodeum with dense pale hair, rest of thorax with dense black hair; that of legs all black except pale patch on outer apices of tibiae; appressed scale-like pubescence of basitibial plate golden. T1 with sparse pale pubescence about length of scape; rest of metasoma with sparse erect black hair up to length of flagellomere 1. *Punctation.* Face as in *A. signata* female.

Type material. Male holotype and allotype: California, Solano Co., 3.2 mi (5 km) W. of Mix Canyon, (about 8 km) NW. of Vacaville, 21 April 1976, both collected on *Phacelia egena* (R. W. Brooks), holotype caught at 0900-0915, allotype caught at 1330- 1345 hrs. [Lawrence]. Paratypes: CALIFORNIA: *Contra Costa Co:* Mt. Diablo, 1 female, 21 May 1937 (E. Ross). *Fresno Co:* 6 mi (9.6 km) S. Coalinga, 1 female, 30 March 1970 (J. Powell); 5 mi (8 km) S. Coalinga, 1 male, 1 female, 17 March 1975 (J. Powell); 4 mi (6.3 km) N. Orange Cove, 2 males, 1 female, 6 April 1957, on *Phacelia* (R. Snelling, M. Stage). *Kern Co:* Woody, 1 female, 29 March 1951, (J. MacSwain). *Madera Co:* San Joaquin Experiment Station, 1 female, 20 April 1953 (H. Childs). *Mariposa Co:* Exchequer Dam, 1 male, 1 female, 9 April 1960, on *Phacelia ramosissima* (R. Snelling), 4 mi (6.3 km) W. Echequer Dam, 1 male, 10 April 1960, on *Phacelia* (R. Snelling); Mariposa, 1 female, 14 May 1960 (R. Snelling); Miami Ranger Station, 1 male, 2 June 1937 (J. Kliewer). *Monterey Co:* Arroyo Seco Camp, 5 mi (8 km) W. Greenfield, Elev. 1000 feet (305 m), 1 female, 15 May 1976, on *Eriodictyon californicum* (R. Brooks), 1 female, 1 May 1957 (P. Torchio), 2 females, 2 males, 5 May 1956 (D. Ribble, P. Torchio). *Riverside Co:* Idyllwild, San Jacinto Mts., 1 male, 18 June 1952 (M. Cazier, et al.). *Santa Barbara Co:* Gaviota Pass, 1 female, 23 April 1966, (J. Powell). *San Benito Co:* San Benito, 1 male, 24 March 1971 (E. Cane). *Solano Co:* 3.2 mi (5 km) W. Mix Canyon, Elev. 1700 feet (518 m), 4 females, 17 April 1976, on *Phacelia egena* (R. Brooks), 6 females, 18 April 1976, 4 females, 1 male, 19 April 1976, 6 females, 1 male, 21 April 1976, 1 female, 30 April 1976, 2 females, 3 May 1976; 2 mi (3 km) W. Mix Canyon, Elev. 1000 feet (305 m), 1 female, 16 April 1976, on *Phacelia egena* (R. Brooks), 3 females, 17 April 1976; 1.5 mi (2 km) W. Mix Canyon, Elev. 1000 feet (305 m), 2 females, 10 April 1976, 3 males, 1 female, 14 April 1976, 1 female, 16 April 1976, 1 female, 17 April 1976 (R. Brooks), 1 female, 2 May 1976 on *Collinsia heterophylla* (S. Armbruster). *Stanislaus Co:* Del Puerto Canyon, 1 female, 20 April 1949, (P. Hurd); Knight's Ferry, 1 male, 10 April 1961, on *Phacelia* (R. Snelling), 1 male, 1 female, 15 April 1961 (R. Snelling, T. Duncan). *Tulare Co:* Lemoncove, 1 female, 14 April 1950, (J. MacSwain). *Yolo Co:* Putah Canyon, 2 males, 1 female, 1 May 1940, on *Phacelia* (G. Bohart). *Unknown Co:* Midway, 1 female, 24 May 1936, (M. Cazier). One paratype deposited at [Berkeley], 45 [Brooks], 1 [Cambridge], 1 [Davis], 5 [Lawrence], 5 [Logan], 12 [Los Angeles], 2 [San Francisco], and 3 [Urbana].

Additional specimens: MÉXICO: Baja California, Sierra San Pedro Martir, Rancho Viejo, Elev. 7000 feet (2134 m), 1 female, 13 June 1953 (P. Arnaud).

Comments. The female from Baja California differs from Californian populations in the admixture of several black with pale hairs on scutum, pale pubescence on upper two-thirds of pleura, lower third of pleura and sterna with black hair, outer apices of tibiae with a patch of amber hair, fore and midlegs with pale hair except anterior margin of tarsus with black hair,

hindleg with black hair, except scopal hairs on anterior and posterior margins pale and metasomal terga laterally with sparse pale hair.

Biology. In the Spring of 1976 I studied the floral visitation by *A. phaceliae* at Mix Canyon, Solano Co., California. Females utilized perennial species of *Phacelia* (Hydrophyllaceae) exclusively for pollen and nectar, when available, visiting the flowers from 0730 to 1630 hours. This is the only known oligolectic species of *Anthophora.* The only time *A. phaceliae* was observed going to a plant besides *Phacelia* for pollen or nectar was at the end of its nesting cycle when an extremely worn female was observed on two different occasions taking pollen from *Eriodictyon californicum* (also Hydrophyllaceae) in one locality and *Collinsia heterophylla* at another. Both females were the last females seen at those localities for the season. In both instances at those sites, females were visiting exclusively *Phacelia* a week before.

The bombyliid fly, *Anthrax limatulus vallicola* Marston, has been reared from nests of *A. phaceliae* (Marston, 1964, incorrectly identified as *A. abruptella*).

Anthophora (Caranthophora) spinacoxa new species

Diagnosis. Hind leg of male greatly modified (Fig. 46c); hind coxa with long spine (Fig. 46e); base of hind femur on inner surface with smaller spine (Fig. 46d); S7, S8 and genital capsule shown in Figs. 46g-j.

Description. Male: Length 10.3 mm; forewing length 6.8 mm. *Structure.* Inner orbits diverging above; shortest distance between eyes equal to 0.81 length of eye; head wider than long; clypeal protuberance in profile 0.50 eye width; flagellomere 1 equal to combined length of next two flagellomeres, 0.65 as long as scape (excluding basal bulb) and 1.18 times as long as last flagellomere; second flagellomere 0.42 length of flagellomere 1; flagellomeres 3-10 about equal in length, longer than wide, individual segment 0.66 length of flagellomere 1; distance between posterior ocelli 1.35 ocellocular distance, distance from median ocellus to posterior ocellus equal to 0.65 ocellocular distance. Marginal cell length 0.71 distance from apex of cell to wing tip; hind wing with cu-v 0.85 times length of second abscissa of M+Cu; vein M 2.50 times as long as second abscissa of M+Cu; jugal lobe 0.4 length of vannal lobe. Basitarsus of foreleg with distinct posterior tooth on apex (Fig. 46a), inner surface concave, margins of concavity carinate; mid leg elongated (Fig. 46b); hind leg greatly elongated (Fig. 46c), coxa with large, blunt, spine projecting ventrolaterally (Fig. 46e), femur with small acute, basal tooth on inner surface (Fig. 46d), tibia greatly flattened with wide, flat bilobed, apical tooth on anterior surface with outer tibial spur inserted near base of tooth, basitarsus flattened with large apical tooth on anterior surface. *Coloration.* Dark reddish brown except mandible (except tips), other mouthparts, wing veins and tarsomeres (apices darker) brownish amber; face with white integumental marks as in Fig. 46f. *Pubescence.* Hair pale, white on head, legs and abdomen but ochraceous on thorax except as noted below. Dark hairs scattered among ochraceous ones on scutum and tegula; inner anterior margin of forebasitarsus with short bristly orange hair; midbasitarsus with well developed midbasitarsal brush of black hair (Fig. 46b, black hair on inner apex of basitarsus also) and posterior margin with long loosely associated hairs; middistitarsal brush weakly developed and black; middistitarsus with orange-brown bristles on inner surface; inner surface of hind leg of femur, tibia and anterior half of basitarsus bare and shiny, inner posterior surface of femur, tibia and posterior half of basitarsus with light orange hair, inner surface of tarsus with brown hair. T1 with long erect white hair except apical margin with short appressed white hair; T2-T5 also with apical bands of short appressed white hair and with a few erect dark hairs on basal halves; metasomal sterna with semierect white hair, S4 with a pair of submedian, subapical patches of black hair; S5 with a median V-shaped patch of black hair; S7, S8 and genital capsule as in Figs. 46g-j. *Punctation.* Clypeus shiny, impunctate medially, and laterally with fine punctures; rest of face as usual. Thorax dull, punctures confluent. Metasomal terga weakly shining, punctures fine with areolate sculpturing between punctures.

Type material. Male holotype: Israel, Jericho, 13 April 1909 [Berlin].

Comments and Etymology. Besides the numerous unique characters such as the shape of the hind leg, S7, S8, etc., *A. spinacoxa* is the only species of *Caranthophora* with well developed spines on its hind coxae.

Anthophora (Heliophila) joetta new species

Diagnosis. Facial marks lemon-yellow (Fig. 47a), upper half of thorax with orange hair, lower half with white; mid and hind legs with black hair on outer surfaces; middistitarsus with well developed lateral fringe of black hair (Fig. 47j); T1-T3 with hair all black except narrow apical white band on T3; T4-T6 with white hair and T7 with dark hair; S7, S8 and genital capsule of male as in Figs. 47b, c, h, i.

Description. Male: Length 10.7-13.7 mm; forewing length 8.5-9.1 mm. *Structure.* Inner orbits diverging above; shortest distance between eyes 0.77 frontal length of eye; malar space linear; clypeal protuberance 0.43 eye width; mandible with subapical tooth; labrum with median apical bilobed process (black) and larger median subapical bilobed process (yellow); flagellomere 1 equal to combined length of next 2.5 flagellomeres, 0.58 as long as scape (excluding basal bulb) and 2.5 times as long as flagellomere 2; second flagellomere 0.86 times as long as flagellomere 3; flagellomeres 3-10 about equal in length

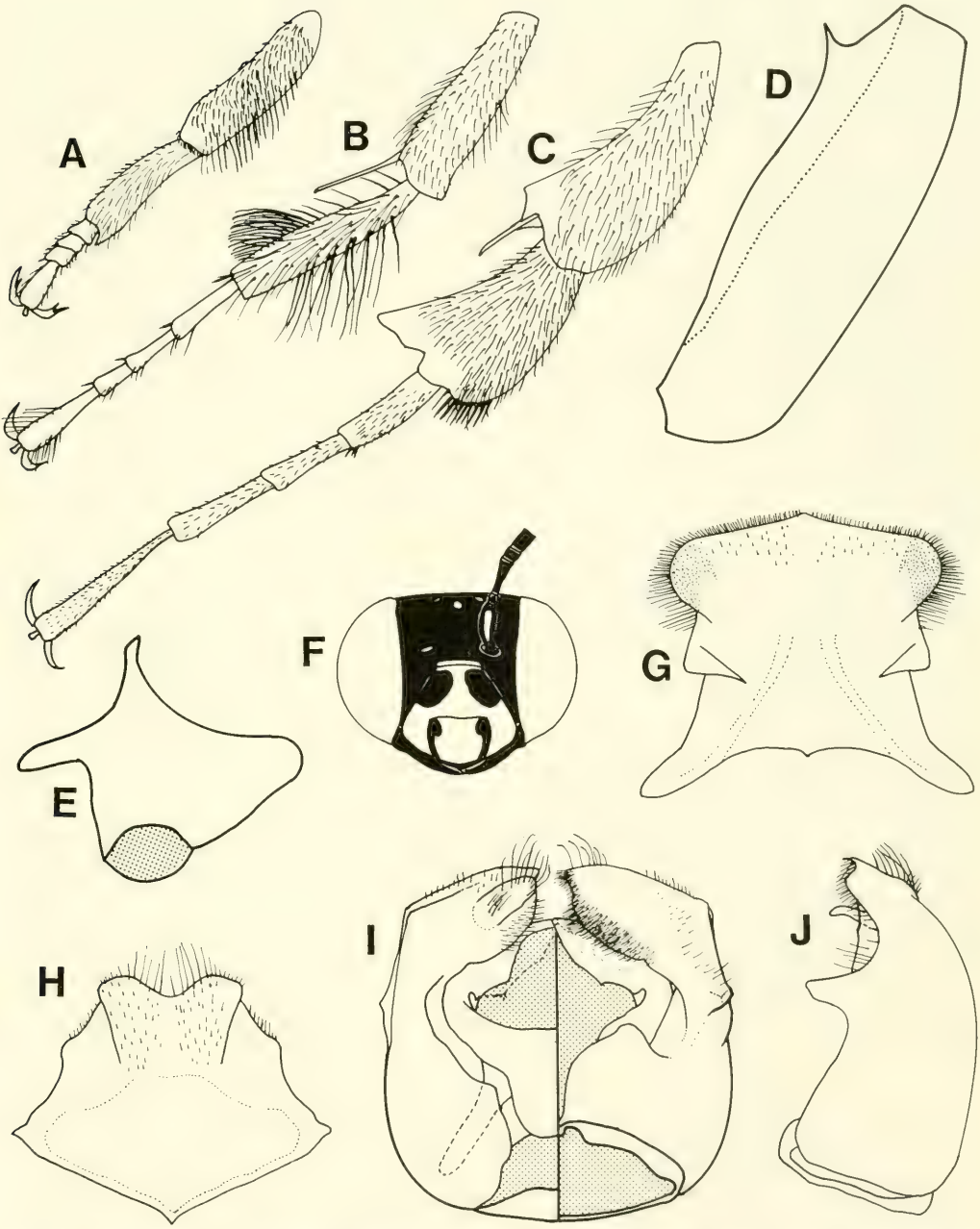


FIG. 46. *Anthophora (Caranthophora) spinacoxa,* male holotype. A-C, Outer views of fore, mid and hind legs. D, Anterior view of hind femur, base of femur at top. E, Hind coxa, side view, base of coxa at top on right side. F, Head, frontal view. G, S7, ventral view. H, S8, ventral view. I, J, Genital capsule, dorsoventral and side views.

vannal lobe; apex of hind tibia on anterior margin with large tooth, outer tibial spur inserted on base of tooth. Pygidial plate apically emarginate, from lateral view with dorsal subapical tooth (Figs. 47d-g); gradular process of T5 developed into a weak tooth, that of T6 a well developed tooth (but see *Comments*) and gradular process of T7 well developed and angulate; S4 apicomedially weakly emarginate; S5 apicomedially deeply emarginate and S6 apicomedially narrowly emarginate; S7, S8 and genital capsule as in Figs. 47c, b, h, i. *Coloration.* Black except facial marks yellow (Fig. 47a) and inner surface of hind tarsus and metasomal sterna reddish-brown. *Pubescence.* Upper half of head and thorax with orange hair, lower half with white hair; foreleg with white hair except anterior surface with blackish-brown hair; midleg with black hair except in inner surface of tarsus (from apical half of basitarsus to claw) white, middistitarsus with well developed lateral

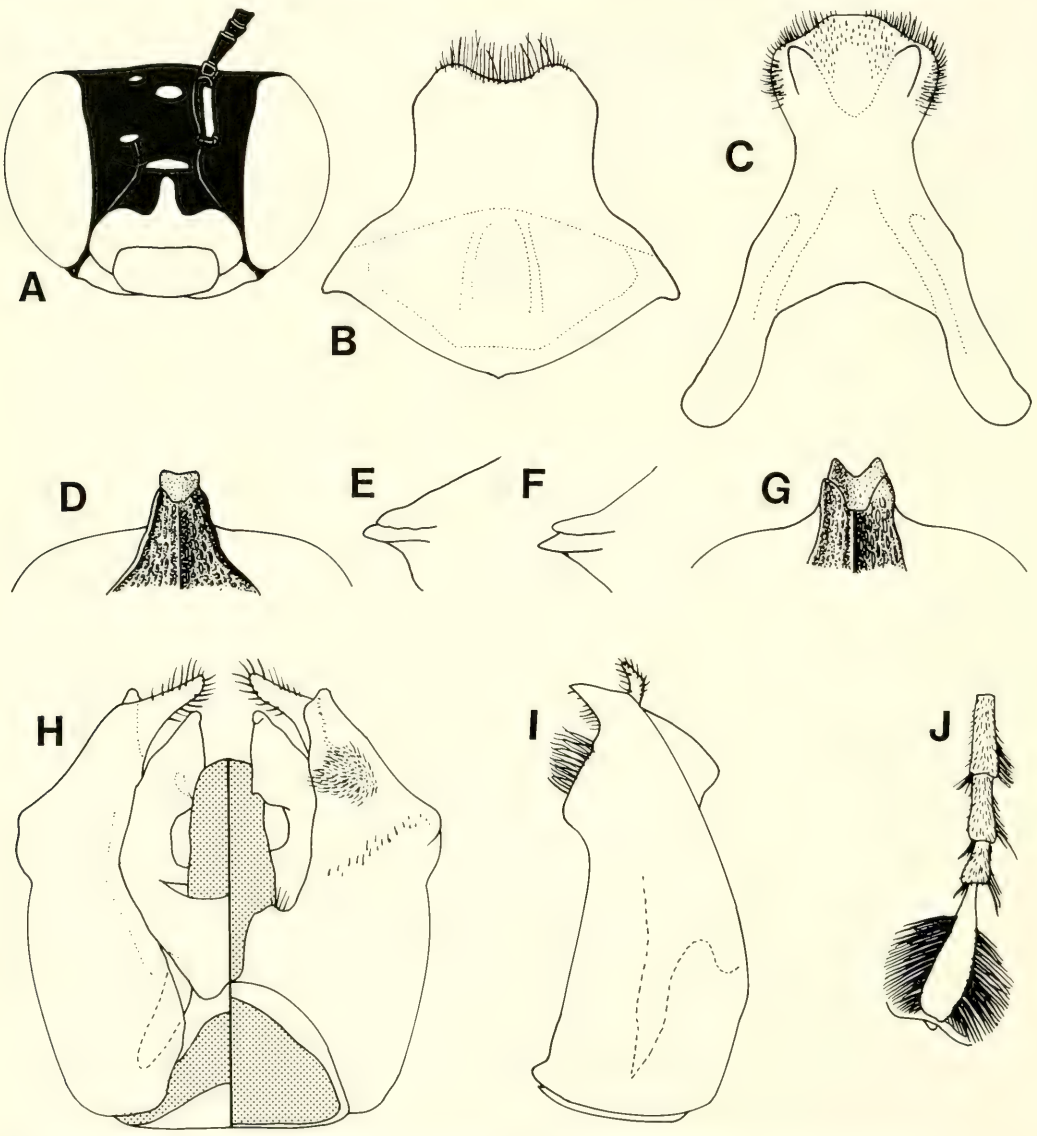


FIG. 47. *Anthophora (Heliophila) joetta,* male paratype. A, Head, frontal view. B, S8, ventral view. C, S7, ventral view. D, E, Apex of T7 of paratype from Zaire, dorsal and side views. F, G, Apex of T7 of holotype from Angola, side and dorsal views. H, I, Genital capsule, dorsoventral and side views. J, Tarsus (excluding basitarsus) of midleg, outer view.

fringe of black hair (Fig. 47j); hind leg with all black except white on inner surface of tarsus (from apex of basitarsus to claw). T1-T3 mostly with black hair but T1 with a few scattered orange hairs and T3 with appressed narrow apical white band; apical half of T4-T6 with white, T7 with orange-brown hair; S1 with pale brownish hair; S2 and S3 with brownish hair, S4 with short brownish hairs apically and laterally but median area (not reaching apical margin) with dense mat of reddish brown hair; S5 with short brownish hair laterally and a narrow band apically but median area (reaching apical margin) with dense mat of yellow orange hair; S6 laterally and broadly apically with short brownish hair but median area (reaching only to apical third) with dense mat of yellow orange hair. *Punctation.* As in *A. micheneri.*

Type material. Holotype male: Angola: 45 mi. [72.4 km] S. Santa Combre Dão, 3 April 1970, Edward S. Ross [San Francisco]. One paratype male: Zaire (B. Congo): 18 mi. [29 km] NW. of Tshinsenda, 8 February 1958, 1330 m altitude, E. S. Ross, R. E. Leech collectors [Lawrence].

Comments. This distinctive species looks superficially much like *Amegilla (Zebramegilla) atribasis* (Cockerell). There is no other species that resembles it in Africa. There are differences between the Angola specimen (holotype) and the Zaire specimen (paratype). The holotype has a distinctive apically emarginate pygidial plate (Fig. 47g) and the gradular process of T6 developed into a tooth whereas the paratype has an almost apically entire pygidial plate (Fig. 47d) and the gradular process of T6 is rounded and not developed into a distinct tooth. The genitalia, however, are identical and although these morphological differences are striking, I believe that they are within the range of variation of this species.

Etymology. This species is named for Joetta Weaver in recognition of her 25 years of painstaking editorial and secretarial contributions for Charles D. Michener and his many students and associates.

Anthophora (Heliophila) micheneri new species

Diagnosis. Body almost completely covered with orange hair similar to that of *Anthophora vestita* Smith; mid and hind legs black except trochanters and coxae with long white hair (male) or mid and hind femur with mostly white hair (female); middistitarsis of male without lateral fringe of black hairs; male and female with bright yellow markings on face (Figs. 48a, b); S7, S8 and genital capsule as in Figs. 48c, f-h.

Description. Male: Length 13 mm; forewing length 7.6 mm. *Structure.* Inner orbits diverging above; shortest distance between eyes 0.79 frontal length of eye; malar space linear; head wider than long; clypeal protuberance 0.42 eye width; mandible with subapical tooth; labrum apically simple and without median subapical process; flagellomere 1 equal to combined lengths of next 1.6 flagellomeres, 0.51 as long as scape (excluding basal bulb) and 1.9 times as long as flagellomere 2, second flagellomere 0.69 times as long as flagellomere 3, flagellomeres 3-10 about equal in length, each 1.22 as long as wide, flagellomere 11 subequal in length to flagellomere 1; distance between posterior ocelli about 1.15 ocellocular distance; distance from median ocellus to posterior ocellus 0.65 ocellocular distance; labrum simple without median apical or median subapical protuberances; cu-v of hind wing about equal in length to second abscissa of M + Cu; vein M 3.53 times as long as second abscissa of M + Cu; jugal lobe about one-third as long as vannal lobe. S4-S6 with dense pads of hair; S7, S8 and genital capsule as in Figs. 48c, f-h. Pygidial plate slightly emarginate apically without sublateral tooth (Figs. 48d, e). *Coloration.* Black except facial marks bright yellow (Fig. 48a). *Pubescence.* Head and thorax on lower half white and upper half yellowish-white; posterior half of scutum with a few scattered dark hairs. Foreleg all white on outer surface, but dark on inner surface; mid and hind legs with hair all black except white on coxae and trochanters and fuscous on posterior surface of midtibia. T1-T6 with appressed orange hair but white to yellow-white laterally; metasomal sterna with white hair, becoming fuscous medially from S3-S6. *Punctation.* Punctures on clypeus and paraocular area fine and separated by 0.5-2.0 puncture widths but fine and nearly contiguous on rest of head. Thorax and metasomal terga dull, weakly shining, punctation contiguous to nearly contiguous.

Female: Length 12 mm, forewing length 8.2 mm. Agrees with description of male except for sex-limited characters and as follows: *Structure.* Shortest distance between eyes 0.91 length of eye; flagellomere 1 equal to combined length of next three flagellomeres and equal to 0.58 length of scape (excluding basal bulb); flagellomeres 2-9 about equal in length and individual segments about as long as wide; last flagellomere 0.77 as long as flagellomere 1; labrum simple without median apical or subapical protuberances. *Coloration.* Facial marks as in Fig. 48b. *Pubescence.* T5 with median patch of dark hair; S1-S3 with sparse apical fringe of white hair; S4 with apical fringe of long white hair and sparse subapical band of dark hair; S6 with dark hair medially, white hair laterally.

Type material. Holotype male and allotype: Kenya: 20 mi. [32.2 km] NE. Magadi, 3500 feet [1066.8 m], 16 June 1967, C. D. Michener [Lawrence].

Comments. This species looks very similar, though smaller in size, to *Anthophora vestita* Smith. The male of *vestita* has a well developed lateral fringe of black hair on the middistitarsus and a deeply emarginate pygidial plate, whereas *micheneri* lacks the fringe of hair on the middistitarsus and has a shallowly emarginate to almost apically

entire pygidial plate. The female of *vestita* has the hind legs with white hairs on the outer surfaces and orange on the inner surfaces, whereas the hind legs of *micheneri* are all black.

Etymology. This species is named for the collector and melittological guide for many students of Apoidea, Charles D. Michener.

Anthophora (Pyganthophora) adamsorum new species

Diagnosis. With mostly red hair; midbasitarsal brush well developed; middistitarsus with weakly developed lateral hair fringe (Fig. 49b); S7, S8 and genital capsule as in Figs. 49c-f.

Description. Male: Length about 13 mm; forewing length about 10 mm. *Structure.* Inner orbits diverging above; shortest distance between eyes 0.81 frontal length of eye; mandible with subapical tooth; head wider than long; clypeal protuberance in profile 0.62 eye width; flagellomere 1 equal to combined length of next 2.7 flagellomeres, 0.87 as long as scape (excluding basal bulb) and 3.3 times as long as flagellomere 2; second flagellomere 0.67 times as long as flagellomere 3; flagellomeres 3-10 about equal in length, each 1.29 times longer than wide; last flagellomere 0.62 times as long as flagellomere 1; distance between posterior ocelli about equal to ocellocular distance; distance from median

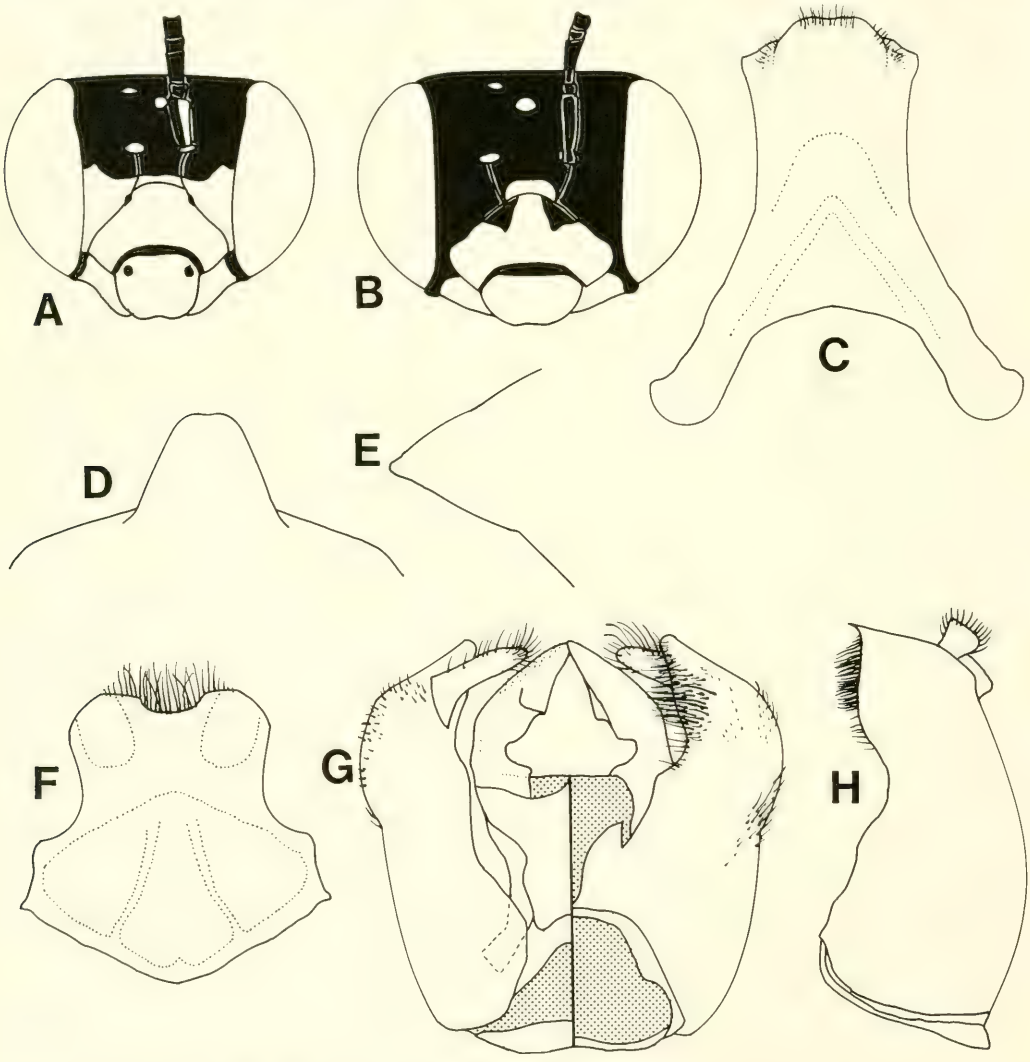


FIG. 48. *Anthophora (Heliophila) micheneri,* male holotype (except B which is head of allotype). A, B, Heads of holotype and allotype, frontal views. C, S7, ventral view. D, E, Apex of T7, dorsal and side views. F, S8, ventral view. G, H, Genital capsule, dorsoventral and side views.

ocellus to posterior ocellus 0.60 ocellocular distance; cu-v of hind wing equal to 0.67 length of second abscissa of M + Cu; vein M 2.3 times as long as second abscissa of M + Cu; jugal lobe about one-third as long as vannal lobe. S7, S8 and genital capsule as in Figs. 49c-f. *Coloration.* Brownish-black except facial marks dark yellow (yellow markings on holotype and paratype reddened, presumably due to cyanide exposure) and tarsi amber-brown. *Pubescence.* Lower half of head and thorax ochraceous, upper half red. Foreleg with ochraceous on outer surfaces and brown on inner surfaces; midleg with ochraceous hair except midbasitarsal brush and hairs on posterior margin dark-brown and lateral hair fringe on middistitarsus fuscous, inner surface of basitarsus brown; hind leg with ochraceous hair, but basitarsus dark brown on inner and outer surfaces (except apex ochraceous). T1 and T2 covered with long, shaggy orange hair; T3 and T4 on apical third with light orange-ochraceous hair and a few scattered dark hairs; basal two-thirds of T4 with short brown hair; T5 and T6 with mostly long, shaggy, dark hair, laterally with long,

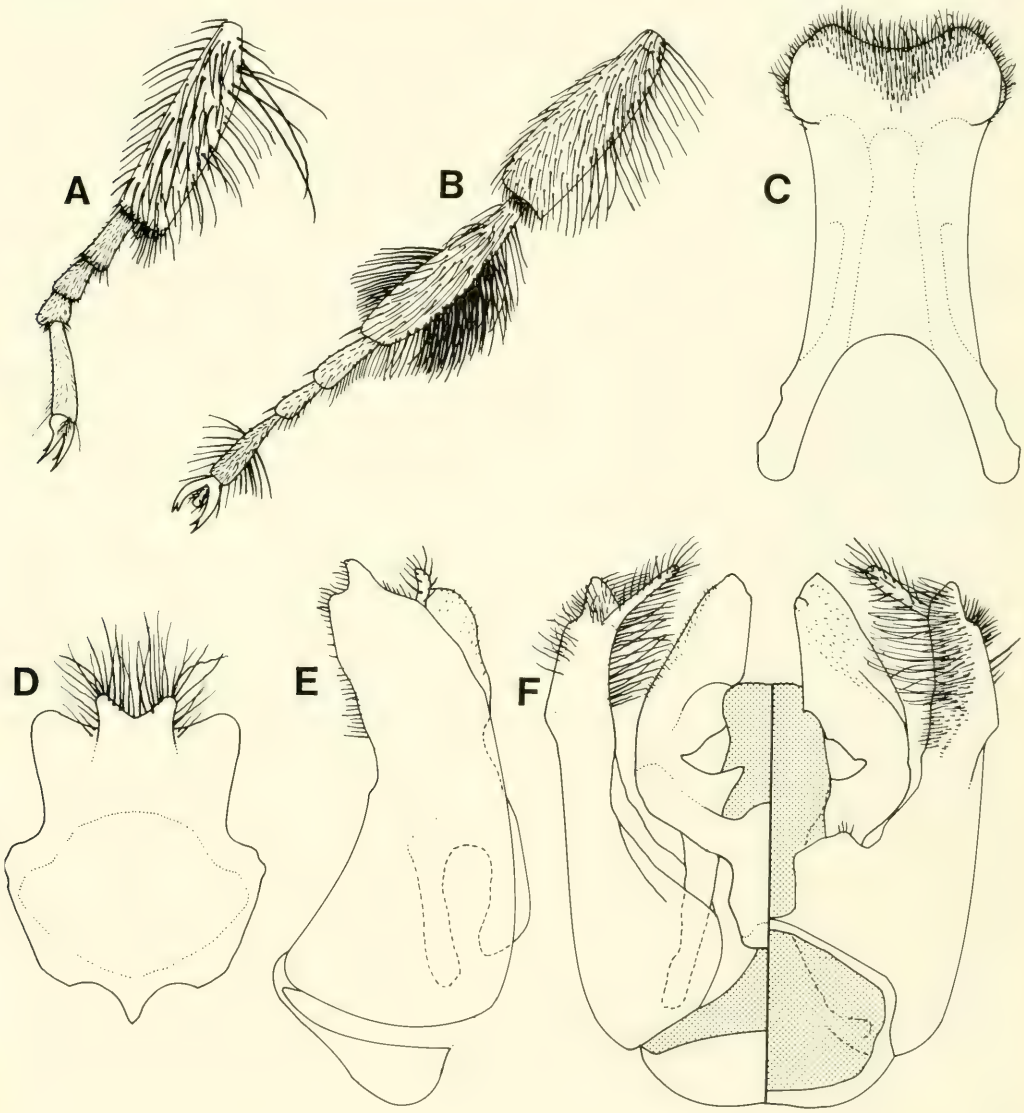


FIG. 49. *Anthophora (Pyganthophora) adamsorum,* male paratype. A, B, outer views of hind tarsus and mid tibia and tarsus. C, S7, ventral view. D, S8, ventral view. E, F, Genital capsule, side and dorsoventral views.

ochraceous hair; T7 with short orange hair; metasomal sterna with long, shaggy, ochraceous hair. *Punctation.* Punctures nearly contiguous to separated by 0.5 puncture-widths on clypeus and paraocular area; punctures much finer and nearly contiguous on rest of head. Thorax dull, punctures contiguous. Metasomal terga shiny, punctures separated by one to three puncture-widths.

Type material. Holotype male and 1 paratype male: China, Zhongguo, 200 km W. Kashgar [=Kashi, 39°29'N, 75°59'E], 17 June 1946, C. L. Li/ Museum Leiden, ex. coll. M. A. Lieftinck. Holotype [Leiden], paratype [Lawrence].

Etymology. This species is named for Ronald and Mary Ann Adams of Lawrence, Kansas, who contributed much to the emotional and spiritual well being of the author, thus enabling the completion of this study.

Amegilla (Micramegilla) canifronoides new species

Diagnosis. Face of female all black; hair mostly black but T1-T4 with white apical bands of hair, partially interrupted on T2 and completely so on T3-T4.

Description. Female: Length 11.5-12.6 mm; forewing length about 9 mm. *Structure.* Inner orbits diverging above; shortest distance between eyes 1.2 length of eye; head wider than long; clypeus moderately protuberant, in profile .41 eye width; flagellomere 1 equal to combined length of next three flagellomeres, about equal to length of scape, and 1.5 times length of last flagellomere; flagellomeres 2-8 equal in length and as long as wide; distance between posterior ocelli equal to 1.2 ocellocular distance, distance from median ocellus to posterior ocellus equal to .44 ocellocular distance. Second submarginal cell receiving first recurrent vein slightly distal to midpoint; marginal cell length .78 distance from apex of cell to wing tip; cu-v of hind wing 1.87 times length of second abscissa of M+Cu; vein M 1.9 times length of second abscissa of M+Cu; jugal lobe .44 length of vannal lobe. *Coloration.* Black except coxae, trochanters, forefemur, anterior surface of midfemur, hind femur, posterior surface of hind tibia and S1-S2 Burnt Sienna. *Pubescence.* Hair on lower two-thirds of face white, upper third black with a few white intermixed. Scutum and metanotum black with some white intermixed; pleura black; propodeal area white; legs black except white patch on outer base of fore and midtibiae, and apicoposterior margin of hind tibia. Metasoma black with apical white bands on T1-T4, band on T1 of about uniform width, on T2 band widest submedially and narrower laterally and medially, on T3-T4 bands interrupted medially but widest submedially and narrow laterally; apical white bands appressed; black hair on T1-T3 appressed with few hairs raised as much as 45 degrees, black hair on T4-T5 raised as much as 60 degrees. *Punctation.* Labrum shiny, rugose-verrucose, rugae weakly and minutely microareolate; clypeus shiny, microareolate, ground between and within cavities weakly microareolate; rest of face shiny, alveolate with smaller cavities than on clypeus and ground between cavities smooth; scutum dull to weakly shiny, alveolate with bump in each alveolus, very near to verrucose, additionally weakly and minutely alveolate between and within larger alveoli, center of scutum less punctate; pleura somewhat more shiny than scutum though weakly so, alveolate like scutum though minute alveolation between large alveoli weaker; propodeal area verrucose. T1-T4 punctate except narrow apical margins, separation of punctures by 0.5-3.0 puncture-widths, T5-T6 more densely and coarsely punctate; metasomal sterna like T1-T4.

Type material. Female holotype: Cape Verde Islands, Brava, September 1898, 600-1000 m, collected by Leonardo Fea [Genoa]. Paratypes: Four females with the same data. One female collected in July at 0-300 m, and another female collected in August at 400-700 m, both on Brava. All paratypes deposited at Genoa except one at Lawrence.

Comments. This species is remarkably similar to *A. canifrons* from the Canary Islands but is smaller and the thoracic hairs are much darker. This species is at least endemic to the Cape Verde Islands, if not to Brava, and is the only species of *Amegilla* in the Cape Verde Islands with a black metasoma having bright white apical bands of hair on the terga.

Etymology: This species is so named after a similar looking species, *Amegilla canifrons* from the Canary Islands.

Amegilla (Micramegilla) capeverdensis new species

Diagnosis. Scopal hairs and hairs of metasoma Mars Yellow (color like that of *A. africana* and *capensis*); face of female all black; thorax with pale hair mixed with some black hair on scutum.

Description. Female: Length 9.7-11.2 mm; forewing length 7.2-7.8 mm. *Structure.* Inner orbits diverging above; shortest distance between eyes 1.1 length of eye; head wider than long; clypeus weakly protuberant, in profile .27 eye width; flagellomere 1 equal to combined length of next 2.6 flagellomeres together, .77 as long as scape (excluding basal bulb), and 1.4 times length of last flagellomere; flagellomeres 2-9 equal in length, 1.1 times as long as wide; distance between posterior ocelli equal to 1.3 ocellocular distance, distance of median ocellus to posterior ocellus equal to .66 ocellocular distance. Second submarginal cell receiving first recurrent vein distal to midpoint; marginal cell length .81 distance from apex of cell to wing tip; cu-v of hind wing 1.43 times length of second abscissa of M+Cu, vein M 2.8 times length of second abscissa of M+Cu; jugal lobe .36 length of vannal lobe. *Coloration.* Face black except apex of clypeus, labrum, and basal two-thirds of mandi-

ble Burnt Sienna; mouthparts and lateral surface of flagellum Cinnamon- Rufous. Thorax black, legs and wing veins Cinnamon-Rufous, wings clear. Metasomal terga and sterna with visible portions of discs black, margins Cinnamon-Rufous. *Pubescence.* Hair on face pale but mixed with some black on vertex, hair densely spaced obscuring paraocular area but rest of facial surface visible. Scutum with pale and black hair intermixed; pleura almost all pale with occasionally only a few black hairs; thoracic sterna, propodeal area, mid and hind coxae, trochanters and femora pale; forefemur with long Fuscous hair; tibiae and tarsi Mars Yellow. Metasomal terga Mars Yellow with lighter apical bands of Warm Buff except T5 with a dense median patch of Fuscous surrounding base of pygidial plate, hair on terga appressed with some semi-erect hair inclined at most as a 45° angle; metasomal sterna Mars Yellow. *Punctation.* Face weakly shining; labrum shiny, rugose, rugae smooth; clypeus coarsely areolate-verrucose, spaces again minutely microareolate; rest of face somewhat more shiny than clypeus, less coarsely microareolate, spaces smooth. Scutum weakly shining, less dull in center, densely punctate at margins, punctures contiguous to .5 puncture-widths apart, but in middle of scutum punctures separated by 0.5-6.0 puncture-widths, ground between punctures finely alveolate; pleura, scutellum and metanotum weakly shining, densely punctate, punctures contiguous to .5 puncture-widths apart, ground between punctures finely microareolate; propodeal area dull, finely alveolate. T1-T4 shiny, punctate except apical margin, separation of punctures 0.5-3.0 puncture-widths, ground between punctures minutely microareolate; T5-T6 coarsely areolate, ground between punctures minutely microareolate; sterna shiny, punctate, separation of punctures 1.0-5.0 puncture-widths, apical margins and gradular area impunctate but these areas as well as ground between punctures minutely alveolate, alveoli often in rows, appearing striate.

Type material. Female holotype: Cape Verde Islands, Boa Vista, December 1897, collected by Leonardo Fea [Genoa]. Paratypes: Twelve females with same data and eight additional females collected in February 1898. All paratypes deposited at Genoa except two paratypes at Lawrence.

Comments. This species is similar in appearance to *A. africana* and *capensis* but is much smaller in size. Besides being presumably endemic to the Cape Verde Islands and being presumably the only yellow *Amegilla* there, it is the only yellow species of *Amegilla* with an all black female face.

Etymology: This species is named after the Cape Verde Islands.

Amegilla (Aframegilla) robinae new species

Diagnosis. Face of male with pale yellow (Aniline Yellow) integumental markings as in Figure 50f; T1-T5 with apical hair bands pale Russian Blue; terminalia as in Figures 50a-d.

Description. Male: Length 13 mm; forewing length 9.2 mm. *Structure.* Inner orbits diverging above; shortest distance between eyes .8 length of eye; malar space linear; head wider than long; clypeus protuberant, in profile .6 width of eye; galea short, reaching slightly posterior to forecoxa; flagellomere 1 equal to combined length of next 2.7 flagellomeres; .8 as long as scape (excluding basal bulb) and 1.5 times as long as last flagellomere; flagellomeres 2-10 about equal in length and about 0.9 times as long as wide; distance between posterior ocelli equal to 1.1 ocellocular distance; distance from median ocellus to posterior ocellus .44 ocellocular distance. Marginal cell length equal to distance from apex of marginal cell to wing tip; vein cu-v of hind wing .8 length of second abscissa of M + Cu; vein M 2.9 times as long as second abscissa of M + Cu; jugal lobe a little less than half length of vannal lobe. S5 broadly and shallowly emarginate, S6 shallowly emarginate apicomedially (Fig. 50e) but apical margin only slightly deflexed ventrally otherwise disc gently convex; S7 apically round, disc with well developed lateral tooth on basal half (Fig. 50d); S8 apically rounded (Fig. 50c); T7 apparently bidentate medioapically but margin between bases of teeth weakly produced medially appearing weakly tridentate (Fig. 50e), without median longitudinal ridge; penis valves small; gonocoxite with well developed inner lobe; genital capsule from dorsal view rounded in outline (Figs. 50a, b). *Coloration.* Black except integumental facial marks Aniline Yellow (Fig. 50f), mouthparts, tegula and S1-S2 Burnt Sienna. *Pubescence.* Face with pale hair except vertex Buckthorn Brown. Thorax Buckthorn Brown with a few black hairs intermixed, sterna pale; coxa pale; foreleg black except inner surface of tarsus Burnt Sienna, outer surface pale; midleg like foreleg except only pale on outer surface of tibia and basal half of basitarsus; hind leg like foreleg except only pale on outer surface of tibia. T1- T5 with apical bands pale Russian Blue with a few scattered dark hairs; rest black. *Punctation.* Clypeus dull, coarsely punctate, punctures separated by 0.5-1.0 puncture-width, ground between punctures coriarious-areolate; labrum shiny, rugulose-lacunose, ground between pits alveolate; paraocular areas shiny, rugulose-lacunose, ground between pits weakly microareolate; supraclypeal area to posterior ocelli coarsely, densely punctate, punctures separated by 1 puncture-width to contiguous. Scutum and scutellum weakly shining, coarsely punctate, punctures separated by 0.5 puncture-width to contiguous; pleura shiny, coarsely punctate, punctures separated by 1.0 puncture-width to contiguous; metanotum and propodeum dull, finely punctate, punctures contiguous. T1-T5 dull, puncticulate, ground between punctures microareolate, apical margin impunctate but microareolate; S1-S2 with

scattered coarse punctures, S3-S6 coarsely punctate, ground between punctures microareolate.

Type Material. Holotype male: Sierra Leone, with no collector or collection date [Genoa].

Comments. A. robinae is the only species of the subgenus *Aframegilla* which has blue metasomal bands of hair and yellow markings on the face of the male. The distinctive shape of the male S7 which has a large lateral tooth midway, the male S8 and the genital capsule (Figs. 50a-d) will separate it from any *Amegilla.*

Etymology. This species is named in honor of my wife Robin, who is not a quantity but a quality collector.

Amegilla (Aframegilla) elsei new species

Diagnosis. Face of male with white integumental markings as in Figure 50l; T1-T5 with apical hair bands pale Russian Blue; terminalia as in Figures 50g-j.

Description. Male: Length 14 mm; forewing length 11.4 mm. *Structure.* Inner orbits diverging slightly above; shortest distance between eyes .8 length of eye; malar space linear; head wider than long; clypeus protuberant, in profile .6 width of eye; galea short, reaching slightly posterior to forecoxa; flagellomere 1 equal to combined length of next 2.3 flagellomeres; .76 as long as scape (excluding basal bulb) and about as long as last flagellomere; flagellomeres 2-10 about equal in length and about 1.26 times as long as wide; distance between posterior ocelli equal to 1.19 ocellocular distance, distance from median ocellus to posterior ocellus .58 ocellocular distance. Marginal cell length equal to 1.05 distance from apex of marginal cell to wing tip; vein cu-v of hind wing .8 length of second abscissa of M + Cu; vein M 2.4 times as long as second abscissa of M + Cu; jugal lobe .4 length of vannal lobe. S5 broadly and shallowly emarginate; S6 shallowly emarginate medioapically, apical margin strongly flexed ventrad (Fig. 50k), T7 medioapically bidentate, margin between teeth simple but with median longitudinal ridge extending anteriorly; S7 apically angulate laterally (Fig. 50j); S8 with lateral margin concave not apically converging (Fig. 50i); penis valves small; gonocoxite with well developed inner lobe; genital capsule somewhat rounded in outline from dorsal view (Figs. 50g, h). *Coloration.* Black except integumental facial marks white (Fig. 50l), mouthparts and foretarsus Burnt Sienna. *Pubescence.* Face with white and black hair from clypeus to vertex; labrum, mandibles and gena with white hair. Scutum, upper half of pleura and scutellum with black and white hair, rest of thorax white; foreleg white with a few black hairs on outer surface of tibia, inner surface of tarsus Burnt Sienna; midleg with femur black, tibia on outer surface white with a few scattered black hairs, rest of midleg black; hind leg similar to midleg except outer surface of tibia all white. T1-T5 with apical bands of appressed pale Russian Blue hair, bands on T1 and T2 narrower, on T3-T5 blue hair scattered over visible portions of terga, T1-T5 laterally with dense white hair, T6-T7 with black hair; S3-S5 with sparse white hair laterally. *Punctation.* Labrum shiny, shallowly rugose-lacunose, ground between pits weakly microareolate; clypeus dull but weakly shining laterally, densely punctate, ground between punctures coarsely microareolate; paraocular and supraclypeal area to vertex puncticulate, ground between punctures weakly microareolate. Scutum weakly shining, densely punctate, punctures separated by 1 puncture-width to contiguous, ground between punctures weakly microareolate; pleura and scutellum weakly shining, densely punctate, punctures separate by 0.5-2.0 puncture-widths, ground between punctures coarsely microareolate; propodeum and metanotum punctulate, dull. Metasoma puncticulate, ground between punctures aveolate.

Type Material. Holotype male: Angola (A37), 5 mi. (8 km) NE. Negola, collected on 25 March, 1972 on the Southern African Expedition of the British Museum (Natural History) 1972-1 [London].

Comments. This species is closely related to *A. caerulea* and *aerizusa* from which it is separated by the lighter blue hair, the shape of the male S7, S8 and genital capsule (Figs. 50g-j). The members of this species group are difficult to separate without comparing male genitalia and associated sterna.

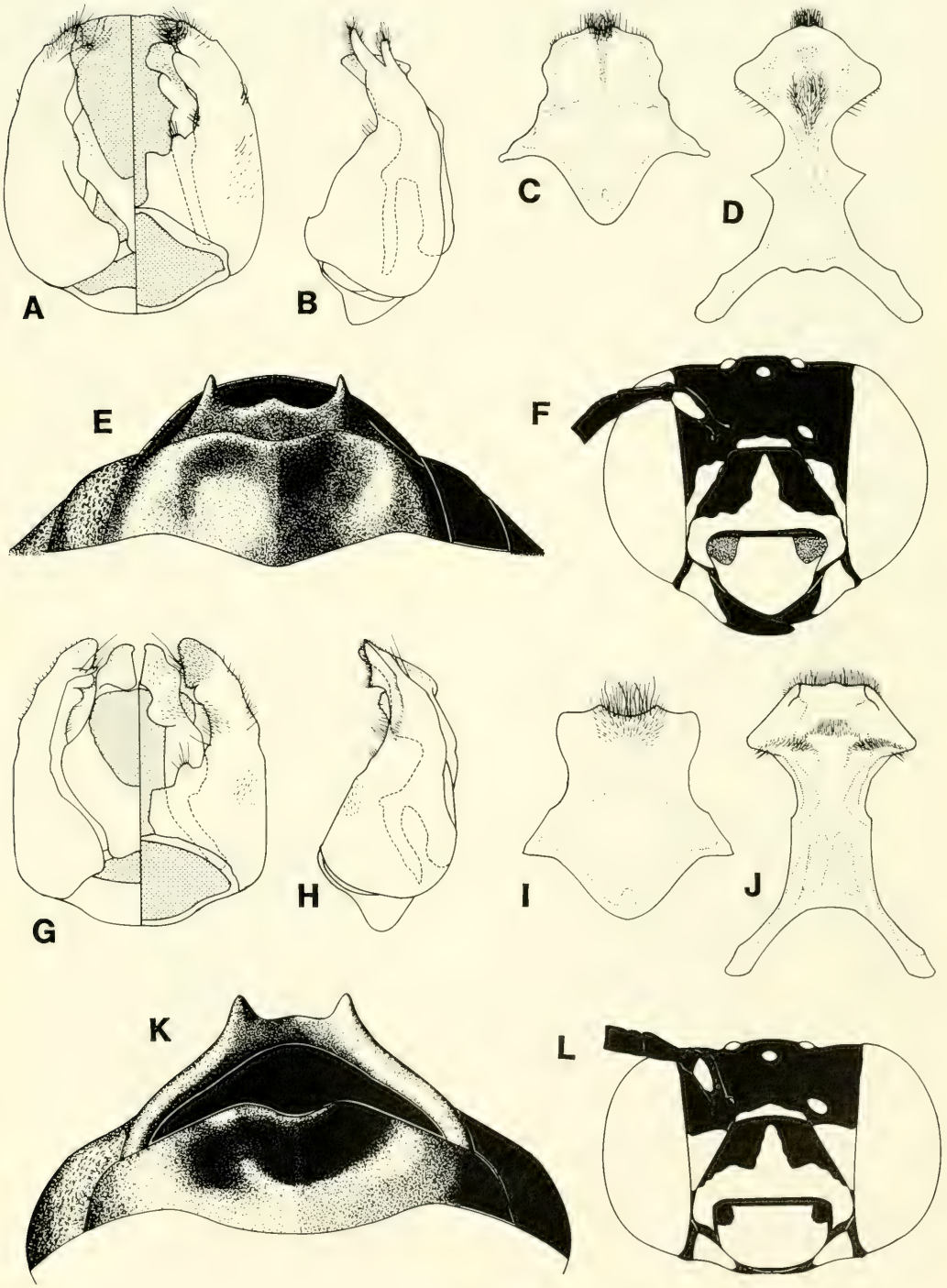
Etymology. This species is named in honor of George R. Else, curator of Apoidea, British Museum (Natural History), for his valuable assistance in this study and for his admirable devotion to and enthusiasm for bee systematics.

Amegilla (Micramegilla) modestoides new species

Diagnosis. Male and female with all black face; hair on face and thorax pale with scattered black hairs; metasoma all black except for pale hairs on T1.

Description. Male: Length 10.0-12.3 mm; forewing length 7.8-8.3 mm. *Structure.* Inner orbits diverging above; shortest distance between eyes .85 length of eye; head wider than long; clypeus moderately protuberant, in profile .47 eye width; flagellomere 1 equal to combined length of next 1.9 flagellomeres together, .63 as long as scape

FIG. 50. New species of *Amegilla (Aframegilla),* males. A-F, *A. (A.) robinae;* G-L, *A. (A.) elsei.* A, B, Genital capsule, dorsoventral and side views. C, D, S8 and S7, ventral views. E, Apex of S6 and T7 (hair omitted), ventral view. F, Head. G, H, Genital capsule, dorsoventral and side views. I, J, S8 and S7, ventral views. K, Apices of S6 and T7 (hair omitted), ventral view. L, Head.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(excluding basal bulb), and equal in length to last flagellomere; flagellomeres 2-10 equal in length and 1.2 times as long as wide; distance between posterior ocelli equal to 1.2 ocellocular distance, distance from median ocellus to posterior ocellus equal to .62 ocellocular distance. Second submarginal cell receiving first recurrent vein slightly distal to midpoint; marginal cell length .88 distance from apex of cell to wing tip; cu-v of hind wing 1.3 times length of second abscissa of M+Cu, vein M 2.2 times length of second abscissa of M+Cu; jugal lobe .4 length of vannal lobe; S6 with weak apicomedian emargination; apex of T7 trilobed such that median tooth is weakly developed and lateral teeth well developed; S7-S8 as in Figures 51c, d, apex of S7 with weakly developed lateral lobes, genital capsule as in Figures 51a, b. *Coloration.* Black except mandi-

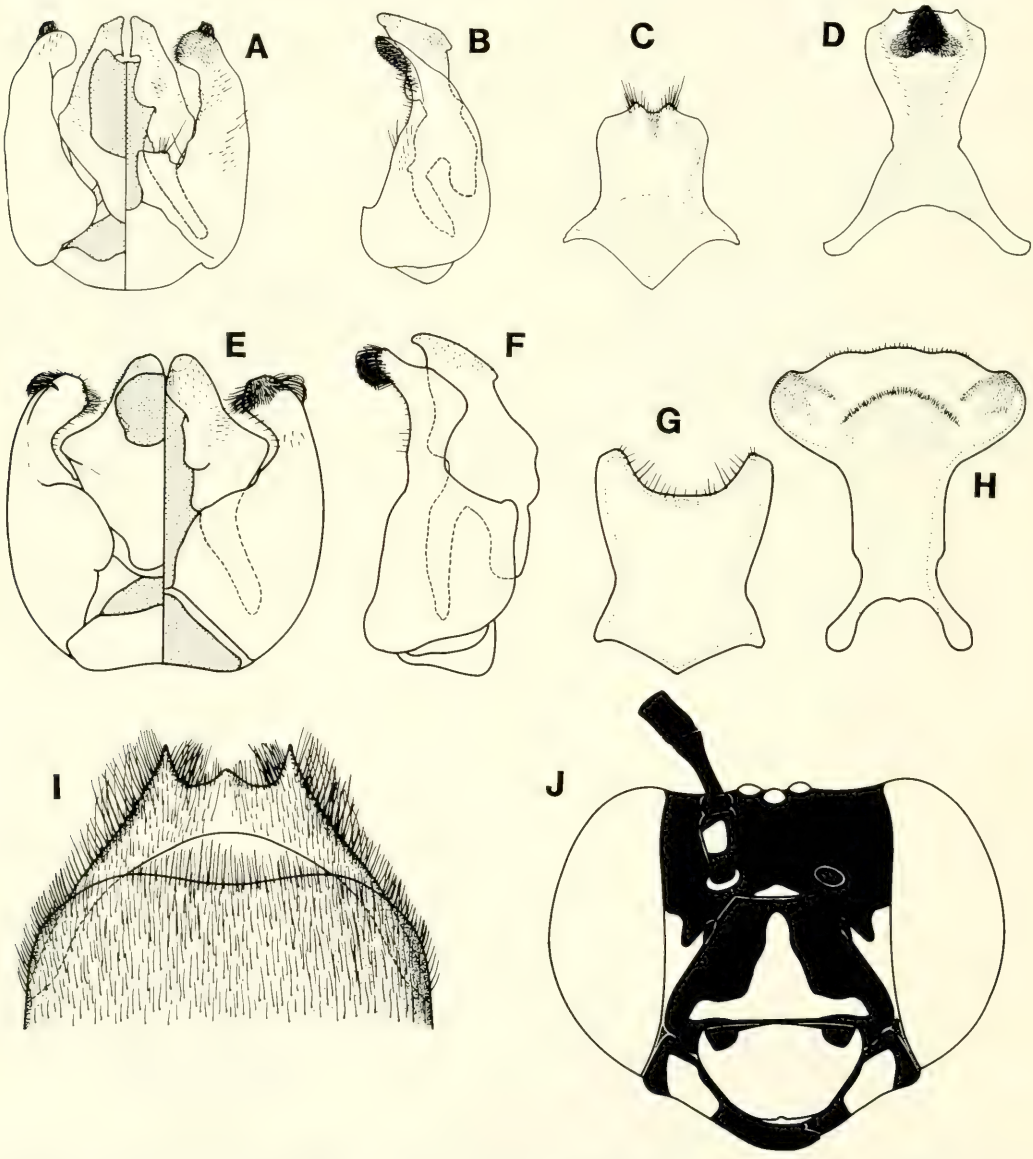

FIG. 51. New species of *Amegilla,* males, subgenera *Micramegilla* and *Glossamegilla.* A-D, *A. (M.) modestoides;* E-J, *A. (G.) lieftincki.* A, B, Genital capsule, dorsoventral and side views. C, D, S8 and S7, ventral views. E, F, Genital capsule, dorsoventral and side views. G, H, S8 and S7, ventral views. I, S6 and T7, ventral view. J, Head.

bles, posterior surfaces of legs and wing veins Claret Brown, wings slightly infuscated, not clear. *Pubescence.* Face, including gena, on lower two-thirds covered with white hair such that surface is obscured but surface of labrum visible, white hair with some black around vertex of head; scutum and upper fourth of pleura pale with black hair intermixed, rest of pleura and thoracic sterna Fuscous; legs Fuscous except outer surfaces of tibiae light Orange-Yellow, apices of mid and hind tibiae with white hair; propodeal area and T1 covered with long pale hair, rest of metasoma black. *Punctation.* Face weakly shiny; clypeus, paraocular and supraclypeal areas microareolate; labrum areolate-rugose, rugae minutely microareolate; vertex punctate, punctures separate by 0.5-10.0 puncture-widths; scutum dull, alveolate and within and between alveoli minutely alveolate; pleura and scutellum dull, obscurely variolate, ground between indentations minutely microareolate; propodeum dull, posterior two-thirds microareolate, anterior third minutely microareolate; metasoma dull, punctate, punctures separated by 1.0-6.0 puncture-widths, ground between punctures weakly imbricate, with narrow apical impunctate margins.

Female: Length 10.7-13.2 mm, forewing length 7.8-9.2 mm. Agrees with male description except for sex-limited characters and as follows: *Structure.* Flagellomere 1 equal to combined length of next three flagellomeres together, .78 as long as scape (excluding basal bulb), and 1.6 times as long as last flagellomere. *Pubescence.* Legs black to Fuscous, with pale hair on outer basal surface of midtibia, and posterior to pencillus on hind tibia; scopal hair Fuscous to Cinnamon-Rufous; T1, in addition to covering of long pale hair, with narrow band of appressed pale hair on apical margin, sometimes T2 and T3 with similar appressed bands of hair but interrupted medially.

Type material. Male holotype: Cape Verde Islands, São Tiago, Orgãos Grandes, May 1898, collected by Leonardo Fea; female allotype with same data [Genoa]. Paratypes: With same data except 2 females collected in March, 18 females and 1 male collected in April, 19 females and 3 males collected in May. All paratypes deposited at Genoa except two males and two females at Lawrence.

Comments. This species is similar in appearance to *A. godofredi* but is smaller in size and the scopa is pale, not orange. Besides being presumably endemic to the Cape Verde Islands, it is the only *Amegilla* which has a black face in both sexes and a black body with pale hair on the head, thorax and T1.

Etymology: This species is named after a similar looking species, *Amegilla modesta* (Smith) (=*A. godofredi* Dours), which is also endemic to the Cape Verde Islands.

Amegilla (Glossamegilla) lieftincki new species

Diagnosis. Female with Beryl Blue mixed with black and white hair on head, thorax, outer surfaces of fore and midtibiae, and apical margins of T1-T4; face of female with only small triangular pale mark on apicomedian half of clypeus; Beryl Blue pubescence of male only on apical margins of T1-T5 and hairs scattered near wing base and on outer surfaces of hind tibia, T7 of male with apicomedian trilobed margin (Fig. 51i), S7 of male with apical half much expanded, apodemes small (Fig. 51h), S8 of male broadly and deeply emarginate (Fig. 51g).

Description. Male: Length 14.6 mm; forewing length 11.2 mm. *Structure.* Inner orbits almost parallel (Fig. 51j); shortest distance between eyes .8 length of eye; malar space linear; head wider than long; clypeus protuberant, in profile .6 width of eye; galea in repose reaching posterior edge of hind coxa; flagellomere 1 equal to combined length of next 2.3 flagellomeres, 1.5 as long as scape (excluding basal bulb) and 1.4 times as long as last flagellomere, flagellomeres 2-10 about equal in length and 1.3 times as long as wide; distance between posterior ocelli equal to 1.3 ocellocular distance; distance from median ocellus to posterior ocellus .2 ocellocular distance. Marginal cell length 1.1 times distance from apex of marginal cell to wing tip; cu-v of hind wing subequal in length to second abscissa of M + Cu; vein M 3.1 times as long as second abscissa of M + Cu; jugal lobe about one-third length of vannal lobe. T7 with apicomedian margin trilobed (Fig. 51i); S6 with weak apicomedian emargination (Fig. 51i); S7 with apical half much expanded (Fig. 51h); S8 broadly and deeply emarginate, disc constricted in basal two-fifths (Fig. 51g); gonocoxite apically simple from dorsal or ventral view (Fig. 51e), in profile basally constricted (Fig. 51f); bridge of penis valve long and wide (Fig. 51e). *Coloration.* Black except pale integumental facial marks (Fig. 51j), coxae, trochanters, femora, and metasomal sterna Burnt Sienna; wing infuscated. *Pubescence.* Face with mixture of black and white hair; gena with white hair; hair on scutum black with a little white hair intermixed, ratio of white to black hair gradually increasing ventrally on pleura to thoracic sterna which is nearly all white, propodeum laterally with long white hair; foreleg with white hair on coxa, with black and white hair on outer surface of tibia and tarsus, femur and inner surfaces of tibia with dark hair, inner surface of tarsus Burnt Sienna; midleg with white hair on coxa, outer surface of tibia and apex of femur with black and white hair, rest of midleg with dark hair; coxa and trochanter of hind leg with white hair; outer surface of tibia with white, black and Beryl Blue hair intermixed, its length about equal to length of scape but long at apex where it is about equal to length of mandible, rest of hind leg with black hair; visible portions of T2-T5 with black hair on basal two-thirds, apical margin with transverse band of pale and Beryl Blue hair intermixed; S1-S4 with pale hair, S5-S6 with dark hair. *Punctation.* Clypeus dull, coarsely punctate, punctures

deep and 0.5-2.0 punture-widths apart, ground between punctures microareolate; labrum somewhat shiny, punctures shallow, nearly confluent, ground between punctures microareolate; paraocular areas shiny, with coarse shallow punctures, ground between punctures finely microareolate; supraclypeal area shiny, with deep coarse nearly confluent punctures; vertex shiny, with coarse to fine punctation, punctures confluent to 4 puncture-widths apart, ground between punctures smooth; scutum weakly shiny with coarse punctures confluent to .5 puncture-widths apart, ground between punctures smooth; pleura shiny, punctation finer than scutum but similar; T1-T4 with visible portions (excluding apical margin bearing pale hair band) dull, coarsely puncticulate, ground between punctures finely microareolate, T5-T7 weakly shining, punctation like preceeding terga except ground between punctures more coarsely microareolate; S1-S3 shiny, with scattered coarse to shallow punctation, ground between punctures microareolate, S4-S6 shiny, punctation nearly confluent.

Female. Length 17 mm, forewing length 13.4 mm. Agrees with description of male except for sex-limited characters and as follows: *Structure.* Flagellomere 1 equal to combined length of next 3.4 flagellomeres, 1.6 as long as scape (excluding basal bulb) and 1.9 as long as last flagellomere; distance between posterior ocelli equal to 1.4 ocellocular distance; distance from median ocellus to posterior ocellus .13 ocellocular distance. *Coloration.* Black except small triangular pale integumental mark on median half of clypeus, legs Burnt Sienna to almost black. *Pubescence.* Facial hair a mixture of black, white, and Beryl Blue; gena with white and Beryl Blue hair on upper half, lower half with white hair; scutum and pleura with mixture of black, white, and Beryl Blue hair; propodeal area with white and black hair; fore and midcoxae with white and black hair, hind coxa with white hair; fore and midtibiae with black and Beryl Blue hair; rest of hair on legs black; T1-T4 like that of male T2-T5; T5-T6 and sterna with black hair. *Punctation.* Thorax somewhat shining, punctures coarse, nearly confluent to .5 puncture-width separation; T5-T6 weakly shining.

Type material. Holotype male: Malaysia, Perak, Larut Hills, 3000-3700 feet (914-1128 m), 16 February 1932. Allotype female: Malaysia, Pahang, Cameron Highlands, Jasar Mt., 5500 feet (1676 m), 25 June 1935. Both holotype and allotype were by H. M. Pendlebury [Leiden]. Paratypes: All from Malaysia: (1 male) Pahang, Fraser's Hill, 4200 feet (1280 m), 22 July 1936; (1 male) Pahang, Cameron Highlands, Tanah Rata, 4800-5000 feet (1463-1524 m), 16 July 1938; (1 male) Perak, Larut Hills, 4500 feet (1371 m), 20 February 1932; (1 male) Pahang, Cameron Highlands, Tanah Rata to Padang, 4800 feet, 1 June 1931; (1 male) Pahang, Cameron Highlands, Tanah Rata to Padang, 3500-4500 feet (1067-1371 m), 17 May 1939; (1 female) Pahang, Cameron Highlands, Pendat Mt., 5170 feet (1576 m), 25 July 1938; (1 female) Pahang, Cameron Highlands, Tanah Rata, 31 January 1940 (H. T. Pagden) on *Crotalaria;* and (1 female) Pahang, Fraser's Hill, 4600 feet (1403 m), 5 June 1941 (H. T. Pagden). Except as otherwise indicated all specimens were collected by H. M. Pendlebury. All paratypes are deposited at Leiden except two males and two females each at Lawrence.

Comments. This striking species is the only known *Glossamegilla* with blue hair, not unlike that of many *Zonamegilla. A. lieftincki* is easily separated from any species of *Zonamegilla,* however, by the presence of metallic blue hair on the thorax as well as the metasoma, by the larger size and by the almost black female face and greatly reduced pale clypeal markings of the male.

Etymology. This species is named in recognition of my late good friend Dr. Maus A. Lieftinck, for his many excellent contributions to anthophorine systematics.

Amegilla nonconforma new species

Diagnosis. Face all black, without pale integumental facial marks. Labrum with apically converging ridges forming a median plate (Fig. 52d); in profile clypeal protuberance 0.45 width of eye; mentum without anterior tooth on basal third; very similar in appearance to *Amegilla paradoxa* n. sp. (see *Diagnosis* of that species).

Description. Female: Length 15 mm; forewing length 11.8 mm. *Structure.* Inner orbits slightly diverging above; shortest distance between eyes 0.87 length of eye; malar space linear; head wider than long; face flat, clypeal protuberance in profile 0.45 width of eye; mandible with subapical tooth; mentum without anterior tooth on basal third; flagellomere 1 equal to combined length of next 3.5 flagellomeres, 0.91 as long as scape (excluding basal bulb) and 2.1 times as long as last flagellomere; flagellomeres 2-9 about equal in length and about as long as wide; distance between posterior ocelli equal to 1.26 ocellocular distance; distance from median ocellus to posterior ocellus 0.42 ocellocular distance; clypeus with apicomedian depressed triangular area, more shiny than rest of clypeus (Fig. 52d); labrum with apically converging ridges forming a median plate (Fig. 52d). Marginal cell length equal to 0.83 distance from apex of cell to wing tip; vein cu-v of hind wing about equal to length of second abscissa of M + Cu; vein M 3.43 times as long as second abscissa of M + Cu; jugal lobe 0.44 length of vannal lobe. *Coloration.* Black except metasomal sterna reddish brown. *Pubescence.* Like *Amegilla paradoxa* except facial hair all white and mixed with black on vertex. Legs all black except outer surface of fore tibia with black and white; fore femur all white except for a few dark hairs anteriorly and base of mid femur with a few

white hairs anteriorly. T1 with white hair on basal two- thirds, T2-T3 all black, S2-S5 with apicomedian band of short orange hair, in addition S3-S5 laterally with white. *Punctation.* Like *Amegilla paradoxa* except face dull, although shiny near posterior ocelli and apicomedian triangular area of clypeus.

Type material. Holotype female: Malawi, Rumpi, Northern Dist., 12 April 1967, C. D. Michener [Lawrence].

Comments. This species is so strange that without the male I am uncertain as to what subgenus it may be in. It possibly is an *Aframegilla.* It is easily recognized by the strangely punctured face and lack of a tooth on the mentum, which suggest *Anthophora,* yet it lacks arolia and has a single basistipital process, features that place it in *Amegilla.* The color and pattern of the pubescence make it look very similar to *Amegilla (Megamegilla) albocaudata* (Dours) and *A. (M.) paradoxa* n. sp., yet the structure of the labrum and all black face easily separate it from those two.

Etymology. This species is so named because it is the only known species of *Amegilla* without an anterior tooth on the basal third of the mentum.

Anthophora (Megamegilla) paradoxa new species

Diagnosis. Clypeus of female completely flat medially, with short dark bristles. Upper half of thorax with red hair, lower half white; T1-T3 with all black; T4 with white hair on apical half; T5 covered with white except black apicomedially; legs essentially all black except some white hair on outer surfaces of tibiae.

Description. Female: Length 17.6 mm; forewing length 13.8 mm. *Structure.* Inner orbits more or less parallel; shortest distance between eyes 0.84 length of eye; malar space linear; head wider than long; clypeal protuberance in profile 0.6 width of eye; galea in repose reaches anterior margin of midcoxa; mandible with subapical tooth; flagellomere 1 equal to combined length of next 3.8 flagellomeres, 1.17 as long as scape (excluding basal bulb) and 2.1 times as long as last flagellomere; flagellomeres 2-9 about equal in length and about 0.87 times as long as wide; distance between posterior ocelli equal to 1.22 ocellocular distance, distance from median ocellus to posterior ocellus 0.52 ocellocular distance. Marginal cell length equal to 0.78 distance from apex of cell

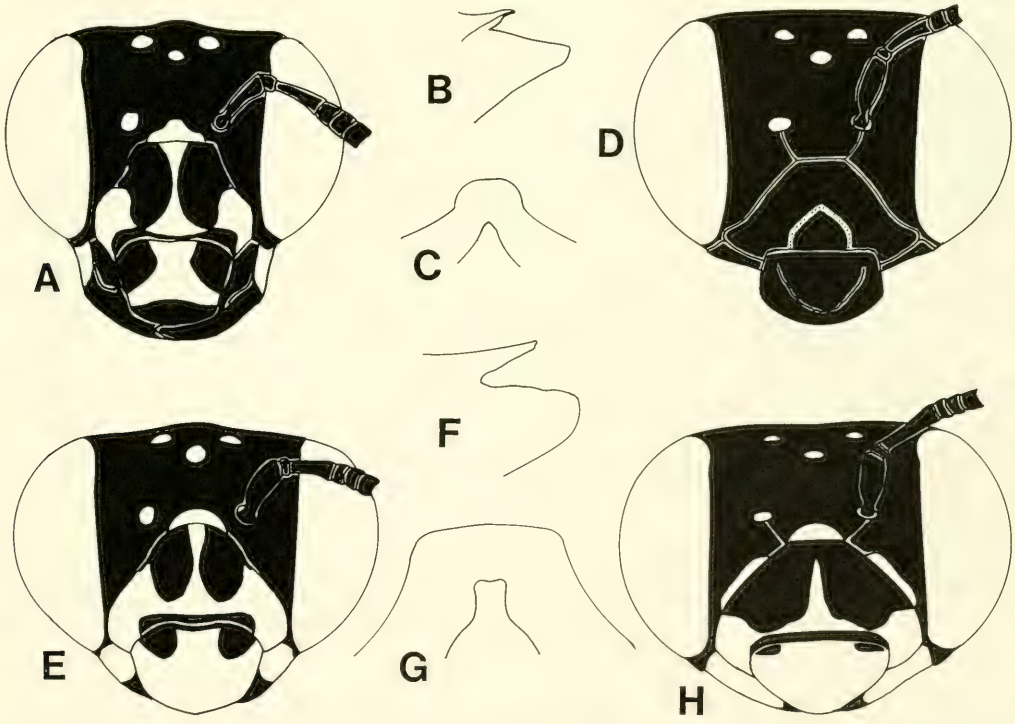

FIG. 52. New species of *Amegilla.* A-C, *A. (Asaropoda) houstoni,* female holotype; head, frontal view; apex of S6, side and ventral views. D, *A. nonconforma,* female holotype, head, frontal view. E-G, *A. (Asaropoda) epaphrodita,* female holotype; head, frontal view; apex of S6, side and ventral views. H, *A. (Megamegilla) paradoxa,* female holotype, head, frontal view.

to wing tip; vein cu-v of hind wing 1.1 length of second abscissa of M + Cu; vein M 3.7 times as long as second abscissa of M + Cu; jugal lobe 0.46 length of vannal lobe. Clypeus and supraclypeal area completely flat medially. *Coloration.* Black except integumental facial marks creamy white (Fig. 52h); tip of mandible and galea reddish brown. Legs reddish black. Metasomal sterna reddish brown. *Pubescence.* Head with mixture of white and black hair but pure white on occiput, gena, mandible and narrowly along paraocular margin; supraclypeal area, clypeus and labrum with fine white hairs, mostly hooked ventrad at apices; in addition supraclypeal area and clypeus with short, stout, straight, dark bristles; labrum basomedially with fine, apically hooked, light brown hairs. Thorax on upper half orange, lower half white; legs with mostly black except mixed with white on outer surfaces of foretibia and foretarsus; midtibia with small patch of white on outer basal surface. T1-T3 all black; T4 on apical half with appressed white hair and a few scattered, semierect dark hairs; T5 with erect white hair laterally but appressed medially, in addition scattered, semierect, dark hair basomedially and a dense black patch of hair apicomedially; T6 all dark except red brown apicomedially; metasomal sterna with dark hair except a fine, short apical fringe on S1, a few hairs apicomedially and apicolaterally on S2, a dense lateral patch on S3-S4 and a few hairs laterally on S5, white. *Punctation.* Almost contiguous on face but weakly shining in interspaces. Thorax shining but surface almost completely obscured by hair. Metasomal terga weakly shining, but sterna more glabrous.

Type material. Holotype female: Malawi, Rumpi, Northern Dist., 12 April 1967, C. D. Michener [Lawrence].

Comments. This species resembles *Amegilla (Megamegilla) albocaudata* (Dours) but can easily be separated from it and any other *Amegilla* species by the strangely flattened clypeal and supraclypeal areas which, in addition, have fine, white, apically hooked hairs mixed with short, stout dark bristles. This type of facial modification is reminiscent of some *Anthophora (Mystacanthophora)* species (see variable 6 in Table 1) and is the first such modification found among anthophorine bees in the Old World. Such a modification has been seen also in an undescribed genus of Eucerini related to *Eucara* in Africa.

Etymology. This species is named for the strangely modified clypeal and supraclypeal area.

Amegilla (Asaropoda) epaphrodita new species

Diagnosis. Head with white (lower half) to light orange (upper half) hair; thorax with black (lower half) and orange (upper half) hair; T1-T3 all black (except T3 with small apicolateral white patch of hair); T4-T6 all white except T6 with apicomedian patch of black hair; S6 with bluntly emarginate subapical tooth (Figs. 52f, g).

Description. Female: Length 15.4-16.2 mm; forewing length about 12 mm. Inner orbits diverging above; shortest distance between eyes 0.83 frontal length of eye; head wider than long; clypeal protuberance in profile 0.59 eye width; mandible with subapical tooth; flagellomere 1 equal to combined length of next 3.1 flagellomeres and 0.91 as long as scape (excluding basal bulb); flagellomere 2 equal to 0.9 length of flagellomere 3; flagellomeres 3-9 gradually increasing in length; last flagellomere equal to 0.71 length of flagellomere 1; distance between posterior ocelli 1.1 ocellocular distance; distance from median ocellus to posterior ocellus equal to 0.47 ocellocular distance. Marginal cell length equal to 0.90 distance from apex of cell to wing tip; cu-v of hind wing about equal to length of second abscissa of M + Cu; vein M 3.95 times as long as second abscissa of M + Cu; jugal lobe 0.47 length of vannal lobe. S6 with large, bluntly emarginate, posteriorly projecting, subapical tooth (Figs. 52f, g). *Coloration.* Black except antenna reddish brown, facial marks yellow (Fig. 52e); median apical margin of clypeus, lateral basal marks of labrum, galea, coxae, trochanters, femora and S1-S4 reddish brown. *Pubescence.* Dense on head and thorax. Lower half to two-thirds of head with white, upper half to one-third orange. Lower half of thorax black (with a few white hairs intermixed), upper half orange; foreleg with coxa, trochanter, femur and tibia having long hair anteriorly but inner surface of femur and inner and anterior surface of tibia with dark hair. T1-T3 black (T3 with appressed white patch apicolaterally); T4-T5 with appressed white hair and scattered dark hairs (apicomedian margin of T4 bare [0.23 mm wide]), T5 also with apicomedian, dense patch of black hair; metasomal sterna all black except for a lateral patches of white hair on S3 and S4. *Punctation.* Face shiny, especially on median yellow mark of clypeus; punctures separated by 0.5-3.0 puncture-widths. Thorax dull, punctures contiguous. Metasomal terga shiny, punctures nearly contiguous to 3 puncture-widths apart.

Type material. Female holotype: Australia, Northern Territory, 15 km E. Mt. Cahill, 12°52'S, 132°50'E, 6-9 March 1978, N. T., M. S. Upton [Canberra]. Paratypes: Four females from Northern Territory, Burnside, Brock's Creek (3 females) 15 February 1932, (1 female) 14 February 1932, T. G. Campbell [3 Canberra], [1 Lawrence].

Comments. The distinctive color pattern given in the *Diagnosis* along with the subapical tooth on S6 will easily separate this species from any other in Australia. The facial markings (Fig. 52e) as well as the pubescent pattern on the metasomal terga will separate *A. epaphrodita* (from the Northern Territory) from the closely related *A. houstoni* (from Western Australia).

Etymology. This species is so named (*epaphroditos,* Gr., lovely, charming) because of its beautiful color pattern and dense, carpet-like pubescence.

***Amegilla (Asaropoda) houstoni* new species**

Diagnosis: Similar to *A. epaphrodita* but facial marks differ (Fig. 52a) and T2 and T3 with well developed apical bands of appressed white hair; vein M 4.67 times as long as second abscissa of M + Cu; S6 with acute subapical tooth (Figs. 52b, c).

Description. Female: Length 15 mm; forewing length 12 mm. Inner orbits diverging above; shortest distance between eyes 0.91 frontal length of eye; head wider than long; clypeal protuberance in profile 0.63 eye width; mandible with subapical tooth; flagellomere 1 equal to combined length of next three flagellomeres and 0.88 as long as scape (excluding basal bulb); second flagellomere equal to 0.84 length of flagellomere 3; flagellomeres 4-9 about equal in length and each segment slightly longer than wide; last flagellomere equal to 0.72 length of flagellomere 1; distance between posterior ocelli 1.18 ocellocular distance; distance from median ocellus to posterior ocellus equal to 0.52 ocellocular distance. Marginal cell length equal to 0.85 distance from apex of cell to wingtip; cu-v of hind wing slightly longer than second abscissa of M + Cu; vein M 4.67 times as long as second abscissa of M + Cu; jugal lobe about half as long as vannal lobe. S6 with distinct acute, posteriorly projecting, subapical tooth (Figs. 52b, c). *Coloration.* Black except facial marks yellow (Fig. 52a); malar space, narrow apical margin of clypeus and median area of mandible reddish brown. *Pubescence.* Like *A. epaphrodita* except T1 with narrow apical band of appressed white hair; T2 with distinct apical white band about twice as wide as that of T1; T3 with distinct apical white band about twice as wide as that of T2; white, appressed, band of hair on T4 departing from margin medially. *Punctation.* Like *A. epaphrodita* but apicomedian margin of T4 impunctate and about twice as wide (0.39 mm).

Type material. Holotype female: Australia, Western Australia, top of Napier Range, Windjana Gorge, Kimberley Div., 10 April 1980, G. Anderson, D. Symor/on *Trichodesma* sp./WAM 87-1303/#350 *Amegilla (Amegilla?)* sp. det 1987, female, by T. F. Houston [Perth].

Comments. This species is most closely related and similar to *A. epaphrodita* from which it differs by the characters given in the *Diagnosis.*

Etymology. This species is dedicated to Terry F. Houston for his meticulously illustrated and fine work on Australian bees.

APPENDIX 2. LECTOTYPIC AND NEOTYPIC DESIGNATIONS

Each section (Lectotypes and Neotypes) of this Appendix is arranged alphabetically by author. Each type designation is arranged in the following sequence: original combination, type locality (TL), sex, label data (L) with each label separated by a slash, type depository in brackets according to the list given in Methods, and notes (if any). Each specimen bears a red lectotype or neotype label.

LECTOTYPES

Lectotypes are designated for various anthophorine and habropodine species when syntypic series exist without published designations of holotypes. Even authors who labelled a type, as distinguished from paratypes or cotypes, often failed to indicate which specimen was the type (= holotype) in their publications. Because of superficial similarity of species in different subgenera, type series are sometimes composite. Designation of lectotypes is the simplest way to clarify such problems. The genus and subgenus to which each name belongs can be determined through the index function of Appendix 3.

T. D. A. Cockerell

Podalirius cleomis (TL: New Mexico, Sante Fe Co., Santa Fe. Male. L: Ckll. 4452., Sta. Fe, NM., Veri Boyle/Co-Type No. 3404 U.S.N.M./ P. cleomis Ckll. COTYPE) [Washington, D.C.]. Cockerell's "cotypes" are normally paratypes, but no "type" (= holotype) can be found for this and the next species.

Podalirius vallorum (TL: New Mexico, Dona Ana Co., Las Cruces. Female. L: Ckll 4795, on *Ipomoea*/Las Cruces NM/P. vallorum COTYPE) [Washington, D.C.].

J. Dours

Anthophora badia (TL: México. Male. L: Mex 58/4 males, 2 females/Anthophora badia n. sp./ Museum Paris, Coll. O. Sichel 1867) [Paris]. 19 male paralectotypes all with the label "Museum Paris, Coll. O. Sichel 1867". In addition 1 had no other label, 2 with "Mex 58", 12 with "Oaxaca", 2 with "Oax. Salle" and 2 with "Orizaba 66" [15 Paris, 4 Lawrence].

Anthophora belieri (TL: Sicily. Female. L: Sicile/153) [Paris].

Anthophora laticincta (TL: France, Corsica. Female. L: Cors/Anthoph laticincta Sich n. s. 3 females/ = nigro-cincta Lp. v. female a Jurin ghli/ Drews, J.) [Paris].

H. Friese

Anthophora fulvitarsis murutica (TL: Afghanistan, Qandahār, Ma'rūt. Male. L: Caucasus, Murut)

[Berlin]. The rest of the type series, 3 males and 1 female, are *Anthophora fulvitarsis* Brullé and are not conspecific with the lectotype.

Anthophora villosula malaccensis (TL: Malaysia, Perak, Taiping Hills. Male. L: Malacca, Taip. Hills, Butt.-Reep, on *Ipomoea*) [Berlin]. The single female of the type series is *Amegilla urens* (Cockerell).

A. Lepeletier de S. F.

Anthophora albigena (TL: France, Lyon. Female. L: A. albigena female) [Paris].

Anthophora balneorum (TL: France, Pyrenees. Female. L: Balneorum female) [Paris].

Anthophora biciliata (TL: Algeria, Oran. Female. L: A. Biciliata female) [Paris].

Anthophora intermedia (TL: France, Paris. Female. L: A. intermedia, St. Farg.) [Paris].

Anthophora romandii (TL: Algeria, Oran. Male. L: Romandii male) [Paris].

F. Smith

Anthophora sicula (TL: Sicily. Female. L: A. sicula Smith/B. M. Type Hym. 17B595b) [London]. Smith's male of *A. sicula* was renamed as *A. pseudosicula* Hedicke, 1929.

Saropoda bombiformis (TL: Australia, New South Wales, Richmond River, 28°53'S, 153°35'E. Female. L: Australia, Richmond River/Smith Collection, Mrs. Farren White, collection no. 99-303) [London]. This is the same specimen that D. B. Baker designated as lectotype in manuscript in 1983.

NEOTYPES

In order to stabilize the following names and place them in subgeneric categories (see the above text) I have designated the following neotypes. Data are presented as for lectotypes.

A. Brullé

No type material of the following Brullé species has been found.

Anthophora affinis (TL: Algeria. Male. L: I. Pons, 13-5/Museum Paris, Coll. J. de Gaulle 1919/A. affinis) [Paris]. The male can be separated from other species by the absence of midtarsal and midbasitarsal brushes and the presence of a middistitarsal brush, as well as an apically emarginate S6. The topotypical neotype agrees with the original description.

Anthophora fulvitarsis (TL: Algeria. Female. L: A. fulvitarsis Brullé) [Paris]. The female has a yellow inverted T-shaped mark on the clypeus and the labrum is mostly yellow. The legs are mostly covered with orange hair; the thorax is ochraceous and the metasomal terga have sparse but distinct apical bands of ochraceous to white hair. The neotype is topotypical and agrees with the original description.

T. D. A. Cockerell

Podalirius cardui (TL: New Mexico, San Miguel Co., Las Vegas. Male. L: Las Vegas, N. M., July 11. (Ckll.)/at flrs. of *Cleome serrulata*/Anthophora cardui Ckll. male) [Washington, D.C.] *P. cardui* is a junior synonym of *Anthophora montana* Cresson. The distinguishing features are illustrated in Figs. 16a, b, d, f-k.

Podalirius lesquerellae (TL: New Mexico, Socorro Co., 12 mi E. (19.3 km) San Antonio (original type locality was Dona Ana Co., Mesilla). Male. L: New Mexico, Socorro Co., 12 mi. E. (19.3 km) San Antonio, IV-11-77, F. D. Parker) [Washington D.C.]. No cotypes of this species have been discovered although I have looked for them in almost every North American collection. The only species of New World *Anthophora (Pyganthophora)* that could be confused with *Anthophora lesquerellae* is *A. vannigera* Timberlake. *A. lesquerellae* male has a black apical rim on the labrum and the subapical tooth is on the apical fifth of the mandible. *A. vannigera* male has no black apical rim (it is all yellow) on the labrum and the subapical tooth is slightly distal to the midpoint of the mandible. *A. lesquerellae* has grey pubescence and is 12-15 mm long.

J. Dours

Almost all of Dours' type material (except for the lectotype material listed above) was destroyed by a bomb at Amiens, France in WW I. An exhaustive search at the Paris Museum, as well as at the museums at Lyon, Geneva, and Basel, failed to turn up any additional Dours' type material.

Anthophora albocaudata (TL: Gabon, N'kogo River, Ogodue, 0°27'N, 9°25'E (original type locality was Guinea). Female. L: Congo Franc., Ogodue N'kogo, J. Bouysson 1901/[Vachal's determination label] 1902, Anthophora albocaudata Dours) [Paris]. *A. albocaudata* can easily be recognized by its large size (about 19 mm), its yellowish-white integumental facial marks, upper half of thorax with orange pubescence, T1-T3 all black and T4 and T5 with mostly white hair. See *Amegilla paradoxa* and *A. nonconforma* for comparison. The neotype agrees with the original description and came from a locality as near to the type locality as I could find.

Anthophora godofredi (TL: Cape Verde Islands, São Nicolau (original type locality was São Vicente). Female. L: Is. Capo Verde, S. Nicolau, 0-600 m, XII-1898, L. Fea/P. Herbst Collection, Ex Reed) [San Francisco]. This species, easily recognized in the Cape Verde Islands, is almost all black but with a conspicuous apical band of white hair on T1 and all of the legs mostly covered with red hair. The neotype agrees with the original description.

Anthophora oxygona (TL: Spain, Sierra de Guadarrama. Male. L: 1149/v. oxygona Drs./Esp.) [Paris]. The name *A. oxygona* has been

applied to various species of *Anthophora*. I have even seen a determination label of *A. oxygona* on an undescribed species of *Pachymelus*. From material in the Paris Museum and studying the original description I am certain that *A. oxygona* is a junior synonym of *Anthophora robusta* (Klug), a well known Mediterranean species. It is easily recognized by its large size (17-20 mm), upper half of the thorax and T1 and T2 with fulvous hair and the middistitarsus without a lateral fringe of black hair. It can be confused with *Anthophora fuliginosa* Morawitz which has a well developed middistitarsal lateral fringe of black hair and is broadly black along all of the lateral margin of the clypeus (*oxygona* has only a small laterobasal spot on its clypeus and is all yellow below the anterior tentorial pit).

Anthophora rufolanata (TL: South Africa, Cape Province, Kaffraria. Male. L: Capland, Willowmore, Aug. 25, 1918, Dr. Brauns) [Pretoria]. This species, endemic to the Cape Province of South Africa, can be recognized and separated from its close relative, *Anthophora vestita* Smith, by the yellow to red hair (mixed with black) on the thoracic and metasomal dorsum and the lack of a middistitarsal lateral fringe of hair. I found 16 specimens at the British Museum (Natural History) determined by Cockerell as *Anthophora rufolanata*. His material agreed well with the original description and I have followed his interpretation of the species.

Anthophora tarsata (TL: México. Male. L: Mejico, Mus: Drews, Tarsata Sichel, 02: sr.) [Copenhagen]. *A. tarsata,* a junior synonym of *Anthophora californica* Cresson, is easily recognized in the western U. S. and the northern half of México by the white, apical, integumental bands on the metasomal terga and the red legs. The hind tibia of the male is greatly inflated with a large anterior tooth. The topotypical neotype agrees with the original description.

Anthophora zonata analis (TL: Equatorial Guinea, Rio Benito, 1°36'N, 9°37'E. Male. L: San Benito, Guiral 1885, 5335-85) [Paris]. This is a dark form of and conspecific with *Amegilla acraensis* (Fabricius). It is almost all black with scattered white hairs on the head, thoracic scutum and anterior half of the thorax, and T4 and T5 have predominately white hair. This topotypical specimen agrees with the original description.

W. Erichson & J. Klug

Megilla sesquicincta (TL: India, Pondicherry State, Karikal. Male. L: SOUTH INDIA, Pondicherry State, Karikal, April 1964 (P. S. Nathan)) [Lawrence]. The supposed type material of *M. sesquicincta* in Berlin, consisting of four specimens, is not from the type locality nor of the proper sex. There is no doubt of its identity from Erichson's description and from where it occurs in India. The head and thorax are almostly completely covered with white hair, T1 and T2 are all black, T3 and T4 have medially interrupted apical bands of white hair and T5 has white hair laterally. See *Comments* under *Dizonamegilla* for further discussion.

E. Germar

Megilla subterranea (TL: France. Male. L: II-23-1837) [Paris]. There is almost no recognizable remnant of Germar's material in the museums at Berlin, Hamburg, Eberswalde, Frankfurt or Munich. In Paris I found material which is topotypical, agrees well with the original description and may even be type material of Germar's. This large species is common in the Mediterranean region. The head has mostly long pale hair, scutum has long black hair, scutellum, metanotum, propodeal area and T1 with long white hair, T2 and T3 with mostly dark hair, and the rest of the terga has mostly white hair except for the median apical patch of dark hair on T5.

J. Giraud

Anthophora obesa (TL: Italy, Piemonte, Fenestrelle. Female. L: 34-72) [Genoa]. This specimen was collected on the 34th expedition on the 26-29 July, 1872 (according to the field notes in the Genoa Museum which were brought to my attention by R. Poggi). I could not find type or topotypical material of *Anthophora obesa* in the Paris Museum. Subsequent searching in other museums uncovered this specimen in Genoa. *A. obesa,* a junior synonym of *Anthophora balneorum* Lepeletier, is recognized by its almost all black head, pale to yellow thorax and almost all black metasoma dorsally, except T1 and T5 apicomedially have pale to yellow hair.

J. Klug

Megilla farinosa (TL: Egypt. Male. L: Aegypten, Schinker/Anthophora farinosa Klg. [Alfken's determination label]/Anthophora farinosa Klug [Lieftinck's determination label]) [Berlin]. The female that is labeled "1467/Type [orange label]/farinosa Klug* [yellow label]/tabsachlich nicht *farinosa* [Lieftinck's handwriting]/ This specimen is not the type, cf. with Priesner 1957, p. 91 [D. Baker's handwriting]" is not *M. farinosa*. From the Klug material in Berlin I have selected as neotype the above male which agrees with Priesner's (1957, see pp. 14, 19 and 90 for separation from other species and a description) interpretation of *Amegilla farinosa*.

A. Lepeletier de S. F.

Anthophora atrocincta (TL: Senegal. Male. L: Cap.) [Paris]. Although most of Lepeletier's species are represented in the Paris Museum collection, I was unable to find suitable material for lectotypic designation. *A. atrocincta* is one of the most distinctive African species. The upper half

of the head and thorax and T3-T5 are covered with thick yellow-orange hair. the lower half of the head and thorax are with thick white hair and T1 and T2 are all black except for a white band of apical hair on T2.

Anthophora nasuta (TL: Algeria, Laghouat (original type locality was Oran). Male. L: Laghouat, S. Algérie, III-IV-29, Dr. R. Meyer/Anthophora nasuta Lep./nasuta Lep. det. Dr. H. Priesner) [Ansfelden]. No type or topotypical material was found in the Paris Museum. The male of *A. nasuta,* a junior synonym of *Anthophora fulvitarsis* Brullé, has the apical margin of the labrum strongly reflexed outward, the midleg has a well developed midbasitarsal and middistitarsal lateral fringes of hair, T1 and T2 are covered with erect pale hair which is denser toward the apical margin, T3-T6 has distinct apical bands of pale hair. This large Mediterranean species is so distinctive that it should not be confused with any other species.

H. Saussure

Habropoda (Pachymelus) heydenii (TL: Madagascar, Diego Suarez. Male. L: Madagascar, Diego Suarez (Vachal Collection) 1911) [Paris]. The type is not in the Senckenberg Museum as indicated by Saussure (1890). There is no type material in Berlin, Paris, Geneva or Basel. The topotypical specimen agrees exactly with the original description and the species can be easily recognized by its essentially all black body with orange hair covering the head, propodeal area, legs, T1, T4 laterally, apical halves of T5-T7 and the sterna.

J. Vachal

Anthophora aerizusa (TL: Gabon, Ogooué (original type locality was Sierra Leone). Male. L: Ogooué/Congo) [Paris]. The locality Ogooué in Gabon can refer to any of the following Provinces: Moyen-Ogooué, Ogooué-Maritime, Ogooué-Ivindo, Ogooué-Lolo or Haut-Ogooué. After looking carefully through the Vachal and other bee collections in the Paris Museum I was unable to locate several Vachal types of anthophorine bees. However, the specimen listed above as neotype agrees with the description of *aerizusa. Amegilla aerizusa* is extremely similar to *A. caelestina* (Cockerell), both of which are bees with powder blue metallic hair on the metasomal terga without a predominance of black hair intermixed (as in *A. guinea* Strand). The only reliable way to separate them is from their differing genital capsules. *A. aerizusa,* from the dorsal aspect, has a definite angle on the lateral margin near the apex of the gonocoxite, the penis valve bridge is basally simple and very small (width of bridge equal to about half the width of the apex of a penis valve from dorsal view) and the gonostylus is short and barely exceeds a line drawn from the inner margin of the apex of the gonocoxite in dorsal aspect. *A. caelestina* from the dorsal aspect has no angle but is smoothly rounded on the lateral margin near the apex of the gonocoxite, the penis valve bridge is basally emarginate and broad (width of bridge equal to about width of the apex of a penis valve from dorsal view) and the gonostylus is long and greatly exceeds a line drawn from the dorsal aspect paralleling the inner margin of the apex of the gonocoxite.

APPENDIX 3. SPECIES OF ANTHOPHORINI AND HABROPODINI WORLDWIDE (INCLUDING INDEX).

The arrangement under each entry is as follows: specific or subspecific name, author, year, current generic status (symbols for names given below), original genus if different from current one in parentheses, zoogeographic region (symbols for regions given below), notes and synonymy or homonymy or new combination, and the page number(s) that refers to that name in the text. Symbols and their meanings for generic names are: Am, *Amegilla;* An, *Anthophora;* Ha, *Habropoda;* Po, *Podalirius;* Un, Unknown to me. Symbols and their meanings for zoogeographic regions are: A, Australian; E, Ethiopian; N, Nearctic; O, Oriental; P, Palearctic; T, Neotropical. If more than one zoogeographic region symbol is given, then the majority of the species' distribution is in the first region and to a lesser extent the species is distributed in the second or even to a lesser extent in the third region.

abessinicus (Friese), 1917 *Pachymelus* (An) **n. comb.**, E, n. name for *An. aethiopica* Friese, 1911, not Cameron, 1905

abdominalis Illiger, 1806 *(Megilla) nomen nudum* = *Ammobates rufiventris* Lepeletier, 1825, according to Gerstaecker, 1869

abjuncta Cockerell, 1922 An, O **(496)**

abramowi Fedtschenko, 1875 An, P **(474, 476)**

abroniae Timberlake, 1937 An, N **(494)**

abrupta Say, 1837 An, N (= *An. sponsa* Smith, 1854) **(448, 451-453, 476-479)**

abruptella Cockerell, see *centriformis* Cresson **(537, 540)**

acervorum Linnaeus, see *plumipes* (Pallas) **(439, 440, 448, 458, 460)**

acraensis (Fabricius), 1793 Am *(Apis),* E (= *An. bipartita* Smith, 1854 **n. syn.**; = *An. flavicollis* Gerstaecker, 1857 **n. syn.**; = *An. analis* Dours, 1869 [as *zonata* ssp.] **n. syn.**, dark form; = *An. hemithoracica* Sichel, *nomen nudum* in Dours, 1869; = *An. advena* Smith, 1879; = *Po. aethiopicus* Cameron, 1905 **n. syn.**; = *An. tellervo* Strand, 1911 **n. syn.**, dark form; = *An. ugandae* Meade-Waldo, 1914 [as *nubica* ssp.]

n. syn., dark form; =*An. nigriventris* Friese, 1922 [as *analis* ssp.] **n. syn.**; =*An. cyanicollis* Friese, 1922 [as *nubica* ssp.] **n. syn.**, dark form; =*An. comperei* Cockerell, 1935 [as *bipartita* ssp.] **n. syn.**; =*An. loveridgei* Cockerell, 1946 [as *flavicollis* ssp.] **n. syn.**, semi-dark form) **(438, 505–507, 557)**

acutilabris Morawitz, 1880 An, PO **(496)**

adamsella (Rayment), 1944 Am (An), A, publication date, not 1942 **(512)**

adamsorum Brooks n. sp., An, P **(438, 462, 544–546)**

adelaidae (Cockerell), 1905 Am (An), A (=*An. ernesti* Rayment, 1944 [as *adelaidae* ssp.] **n. syn.**, publication date, not 1942, see Text Fig. IX, figs. 3b, 4c and described as new 1947) **(511)**

advena Smith, see *acraensis* (Fabricius)

adveniformis Cockerell, see *albocaudata* (Dours)

advenula (Cockerell), 1930 Am (An), E **(515)**

aegyptiaca (Dalla Torre Friese), 1895 An *(Megilla)*, n. name for *An. senilis* Walker, 1871, not Eversmann, 1846 **(460)**

aegyptorum Priesner, see *atricilla* Eversmann

aeneiventris Hedicke, 1931 An, P **(484, 486)**

aerizusa (Vachal), 1903 Am (An), E **(506, 548, 558)**

aeruginosa (Smith), 1854 Am (An), A **(438, 511, 512)**

aestivalis Panzer, see *retusa* (Linnaeus) **(462)**

aethiopica (Friese), see *abessinicus* (Friese)

aethiopicus Cameron, see *acraensis* (Fabricius)

affabilis Cresson, 1878 An, N (=*An. fulvicollis* Timberlake, 1951 **n. syn.**) **(466)**

affinis Brullé, 1832 An, P (=*An. liturata* Lepeletier, 1841 **n. syn.**; =*An. asiatica* Morawitz, 1880; =*An. lusitanica* Friese, 1919 [as *asiatica* ssp.] **n. syn.**) **(464–466, 556)**

afimbriata LaBerge & Michener, see *badia* (Dours)

aflabellata Gribodo, 1926 An, P **(466)**

afra Priesner, see *albigena* (Lepeletier)

africana (Friese), 1905 Am (An), E (=*An. pseudococcina* Meade-Waldo, 1914, **n. syn.**; =*An. odontura* Cockerell, 1920, **n. syn.**) **(506, 546, 547)**

africana Benoist, see *balneorum* Lepeletier

agama Radoszkowsky, 1869 An, PO (=*An. kessleri* Fedtschenko, 1875, **n. syn.**) **(464–466)**

agamoides Strand, see *dalmatica* Pérez

agilis Smith, see *badia* (Dours)

alaica Hedicke, see *retusa* (Linnaeus)

alamosanus Cockerell, see *urbana* Cresson

alashanica Gussakovsky, see *pekinensis* Cockerell

albata Cresson, 1876 An, N **(494)**

albella Gussakovsky, 1935 An, P **(491)**

albescens Dours, see *quadrifasciata* (de Villers)

albiceps (Rayment), 1951 Am *(Asaropoda)*, A **(515)**

albiceps Friese, 1916 An, T, not Friese, 1922 **(468)**

albiceps Friese, see *arequipensis* Brèthes

albicilla Pérez, 1895 An, P **(464, 486)**

albida Dours, see *albigena* (Lepeletier)

albifascies Alfken, 1936 An, O **(484, 486)**

albifronella Brooks An, P, n. name for *Heliophila albifrons* Wu, 1985, List of Insects of Mt. Tumur, Tienshan, *in* Biology of Tienshan, Beijing, p. 148-149 (in Chinese, English summary on p. 150) not *An. albifrons* Eversmann, 1852 or Smith, 1854 **(491)**

albifrons Smith, see *arequipensis* Brèthes

albifrons Eversmann, see *bimaculata* (Panzer)

albifrons Wu, see *albifronella* Brooks

albigena Lepeletier, 1841 Am (An), P (=*Megilla leucomelaena* Illiger, 1806 **n. syn.**, *nomen nudum*; =*Megilla moribunda* Illiger, 1806 **n. syn.**, *nomen nudum*; =*Antophora (sic) binotata* Lepeletier, 1841 **n. syn.**; =*An. albida* Dours, 1869 [as *albigena* ssp.] **n. syn.**; =*An. nana* Radoszkowsky, 1869 [as *quadrifasciata* ssp.] **n. syn.**; =*Po. nigrithorax* Dalla Torre, 1877 [as *albigena* ssp.]; =*Po. pyramidalis* Kirby, 1900 **n. syn.**; =*An. afra* Priesner, 1957 [as *albigena ssp.*] **n. syn.**) **(438, 499, 502–504, 556)**

albigena Rayment, see *albigenella* Michener

albigenella Michener, 1965 Am, n. name for *Asaropoda albigena* Rayment, 1931, not Lepeletier, 1841 **(515)**

albipes Friese, see *plumipes* (Pallas)

albobarbata Hedicke, 1936 An, P **(462)**

albocaudata (Dours), 1869 Am (An), E (=*An. adveniformis* Cockerell, 1946 **n. syn.**) **(506, 553, 554, 556)**

albocinerea Saunders, see *humilis* (Spinola)

alboferrugineus Friese, see *ferruginea* Lepeletier

albomaculata Radoszkowsky, see *dubia* Eversmann

albomarginata Timberlake, see *californica* Cresson

albopicta Cockerell, 1917 An, P **(491)**

albopictula Cockerell, see *oldi* Meade-Waldo

albopunctata Illiger, see *violacea* (Lepeletier)

alboscopacea (Friese), 1922 [as *circulata* ssp.] Am (An), E **(504)**

albosignata (Friese), 1896, An (Po), P (=*An. fastuosa* Gribodo, 1924, **n. syn.**; =*An. tenuiciliata* Alfken, 1926) **(460, 464)**

alfierii Alfken, see *caelebs* Gribodo

alfkenella Priesner, 1957 An, P **(491)**

aliceae Cockerell, see *praecox* Friese

alluaudi Pérez, 1895 An, P (=*Po. canariensis* Saunders, 1903; =*An. fuerteventurae* Lieftinck, 1958 [as *alluaudi* ssp.] **n. syn.**) **(460, 462)**

alpatovi Kuznetzov-Ugamsky, 1927 Un (An), P **(450)**

alpha (Cockerell), 1904 Am *(Saropoda)*, A **(515)**

altaica Radoszkowsky, 1882 An, P (=*Megilla tersa* Erichson, 1849 **n. syn.**) **(460, 462)**

alternans (Klug), 1845 An *(Megilla)*, P (=*Po. wegeneri* Friese, 1899, **n. syn.**) **(474, 476)**

alticola Hedicke, see *quadrimaculata* (Panzer)

ambigua Pérez, see *rivoletti* Pérez

ambitiosa Alfken, 1935 [as *femorata* ssp.] An, P **(474, 476)**

amolita Cockerell, see *subcoerulea* (Lepeletier)

amphigynops Cockerell, see *niveata* (Friese)

ampliceps Friese, see *vestita* Smith

amseli Hedicke, 1936 An, P **(464, 466)**

amymone (Bingham), 1896 Am (An), O **(513)**

analis Dours, see *acraensis* (Fabricius) **(557)**

andalusica Pérez, 1902 An, P **(464)**

andersoni Cockerell, see *mimadvena* (Cockerell)

andicola Schrottky, 1911 An, T **(468)**

andinensis Ruiz, 1940 (Po) *nomen nudum*

andresi (Friese), 1914 Am (An), P (=*An. glauca* Alfken, 1926) **(510)**

andrewsi (Cockerell), 1910 [as *zonata* ssp.] Am (An), O **(509, 511)**

angolensis (Dalla Torre), 1896 An (Po), E, n. name for

An. atriceps Pérez, 1895, not Radoszkowsky, 1881 **(460, 462)**
angulosa Hedicke, 1940 Un (An), P **(450)**
angustula Zetterstedt, 1838 (An) = *Osmia parietina* Curtis, 1828 according to Tkalců, 1983
annos (Vachal), 1903 Am (An), E (= *An. leucocephala* Friese, 1922 **n. syn.**) **(515)**
annulifera Walker, 1871 Un (An), P **(450)**
anomala (Cockerell), 1929 Am *(Asaropoda),* A **(515)**
anpingensis Strand, see *korotonensis* (Cockerell)
anstrutheri Cockerell, see *flavocincta* Huard
antennatus Kirby, 1900 (Po), transferred to *Tetralonia tricincta* Lepeletier, 1841, by Cockerell, 1909
anthoeca Illiger, 1806 (An) *nomen nudum* = *Osmia caementaria* Gerstaecker, 1869, according to Gerstaecker, 1869
anthracina Gribodo, see *violacea* (Lepeletier)
anthreptes Lieftinck, see *pendleburyi* (Cockerell)
antimena (Saussure), 1890 Am (An), E **(504)**
antiope Bingham, see *atroalba* Lepeletier **(462)**
apatelia Lieftinck, see *krishna* Bingham
apicalis Guérin-Méneville, 1845 (An) [as *versicolor* ssp.], = *Centris* (Anthophoridae; Centridini)
apostasia Lieftinck, 1974 Ha, O
appletoni Cockerell, 1946 An, E **(491)**
arabica Priesner, 1957 An, P **(462)**
arcana (Cockerell), 1936 Am (An), E **(508)**
arctica Morawitz, 1883 An, P **(481, 482)**
arequipensis Brèthes, 1920 An, T (= *An. albifrons* Smith, 1854 not Eversmann, 1852; = *An. escomeli* Brèthes, 1920 **n. syn.**, dark form; = *An. albiceps* Friese, 1922 **n. syn.**; = *An. boliviensis* Friese, 1922 **n. syn.**; = *An. niveiceps* Friese, 1925 [as *albiceps* ssp.] **n. syn.**; = *An. tricincta* Friese, 1925 **n. syn.**) **(452, 456, 466, 468, 469)**
argyrospila Cockerell, 1938 An, E **(492)**
arida Brooks An, P, n. name for *An. desertorum* Priesner, 1957, Bull. Soc. Entomol. Egypte 41:45-47, not Gussakovsky, 1935 **(464)**
arietina Dours, see *fulvitarsis* Brullé
armata Friese, 1905 An, E (= *An. clitelligera* Friese, 1905 [as *armata* ssp.] **n. syn.**; = *An. pseudobasalis* Strand, 1911 **n. syn.**; = *An. optima* Cockerell, 1921 **n. syn.**; = *An. tetra* Friese, 1922 [as *armata* ssp.]; = *An. megasoma* Cockerell, 1933 **n. syn.**) **(476)**
armatilabris Friese, see *rufolanata* Dours
armatipes Friese, see *conspicuus* Smith
arthuri Cockerell, 1906 An, N **(494)**
aschabadensis Radoszkowsky, 1893 An, P **(496)**
asiatica Morawitz, see *affinis* Brullé
aspergina (Cockerell), 1933 Am (An), E **(515)**
aspilostoma Cockerell, see *rubricans* (Cockerell)
asserta (Cockerell), 1926 Am (An), A **(511)**
assertiella Rayment, see *perasserta* (Rayment)
astragali Morawitz, 1878 An, P **(450, 476)**
aterrima Cockerell, see *bomboides* Kirby
atlantica Alfken, see *canifrons* (Smith)
atra Friese, see *robusta* (Klug)
atra Hedicke, see *robusta* (Klug)
atramentata Cockerell, see *plagiata* (Illiger)
atrata Cresson, 1865 An, T **(468)**
atrata Hedicke, see *furcata* (Panzer)
atratula Friese, see *robusta* (Klug)
atribasis (Cockerell), 1933 Am (An), E **(502, 504, 543)**
atriceps Pérez, see *angolensis* (Dalla Torre)
atriceps (Radoszkowsky), 1881, Am (An), P **(515)**
atricilla Eversmann, 1846, An, P (= *An. aegyptorum* Priesner, 1957 [as *atricilla* ssp.] **n. syn.**) **(464–466)**
atrifrons Smith, see *quadricolor* Erichson
atripes (Friese), 1922 [as *zonata* ssp.] Am (An), O **(511)**
atripes Friese, see *pilifrons* Packard
atroalba Lepeletier, 1841 An, P (= *An. antiope* Bingham, 1898 **n. syn.**; = *Po. vedettus* Nurse, 1904 **n. syn.**) **(460, 462)**
atrocaerulea (Dours), 1869 [as *zonata* ssp.] Am (An), O **(511)**
atrocincta (Lepeletier), 1841 Am (An), E (= *Apis plumipes* Fabricius, 1781, not Pallas, 1772; = *An. domicola* Cockerell, 1908 **n. syn.**; = *An. latipes* Friese, 1922 **n. syn.**) **(502, 508, 510, 557)**
atroferruginea Dours, 1869, see *robusta* (Klug)
atroscopacea Friese, see *robusta* (Klug)
aurata (Friese), 1911 Am (An), A **(513, 515)**
aureohirta Cockerell, see *tetradonta* Cockerell
auripes Morawitz, 1886 An, P **(482)**
aurulentocaudata (Dours), 1869 *Deltoptila* (An), T (= *An. terminata* Smith, 1879, p. 119; = *Po. habropodoides* Dalla Torre, 1896, n. name for *An. terminata* Smith, 1879, p. 119, not Smith, 1879, p. 121, **n. syn.**)
australis (Rayment), 1944 Am (An), A, publication date not 1942 **(511)**
bactriana Popov, An, *nomen nudum* by Ponomareva, 1960 **(439)**
badia (Dours), 1869 *Deltoptila* (An), T (= *Ha. montezumia* Smith, 1879 **n. syn.**; = *Ha. agilis* Smith, 1879 **n. syn.**; = *Ha. bombyformis* Smith, 1879 **n. syn.**; = *Po. bremiformis* Dalla Torre, 1896 [n. name for *bombyformis* Smith, 1879, not Smith, 1854] **n. syn.**; = *Deltoptila afimbriata* LaBerge & Michener, 1963 **n. syn.**) **(555)**
bahamensis Brooks n. sp. An, T **(438, 466, 468, 533–537)**
baicalensis Hedicke, see *retusa* (Linnaeus)
balassogloi Radoszkowsky, 1877 Ha, P
balearica (Friese), 1896 An (Po), P (= *Po. moraguesii* Friese, 1896 [as *balearicus* ssp.] **n. syn.**) **(460, 462)**
balneorum Lepeletier, 1841 An, P (= *An. obesa* Giraud, 1863; = *An. nigrovittata* Dours, 1869 **n. syn.**; = *bicolor* Sichel **n. syn.**, *nomen nudum* by Dours, 1869; = *An. subcarinata* Benoist, 1930 [as *balneorum* ssp.] **n. syn.**; = *An. africana* Benoist, 1930 [as *balneorum* ssp.] **n. syn.**) **(470, 472–474, 476, 556, 557)**
baltistanica Hedicke, see *plagiata* (Illiger)
barbipes Fedtschenko, 1875 An, P **(476)**
basalis Smith, 1854 An, E **(473, 474, 476)**
basizona Illiger, 1806 *(Megilla) nomen nudum*
bechuanensis (Cockerell), 1935 Am (An), E **(504)**
beharensis Benoist, 1962 *Pachymelus,* E
beijingensis (Wu), 1987 An *(Anthomegilla),* P **(482)**
belieri Dours, 1869 An, P (probable *lapsus* since it seems the species was named for J. B. E. Bellier de la Chavignerie, a contemporary of Dours; however, Dours never mentions his name in 1869 or in subsequent papers) **(460, 462, 555)**
bembidion Lieftinck, 1966 *Elaphropoda,* O

bequaerti (Cockerell), 1930 Am (An), E **(504)**
berylae (Rayment), 1947 Am (An), A **(511)**
bettoni Cockerell, see *conspicuus* Smith
bicalcarata Hedicke, see *disparilis* Friese
biciliata Lepeletier, 1841 An, P (=*An. caucasica* Radoszkowsky, 1874; =*An. mucida* Gribodo, 1873; =*An. morawitzi* Alfken & Blüthgen, 1937 [=*ventilabris* of Morawitz, 1895, not Lepeletier, 1841]) **(464–466, 556)**
bicincta Fabricius, see *sesquicincta* (Erichson & Klug) **(505)**
bicolor (Saussure), 1890 *Pachymelus* (Ha) **n. comb.**, E
bicolor Sichel, see *balneorum* Lepeletier
bicornis Zetterstedt, 1838 (An) =*Osmia* (Megachilidae)
bidentata Provancher, see *terminalis* Cresson
bifasciata Fedtschenko, 1875 An, P **(465)**
bihamata Panzer, 1809 Un *(Apis),* P **(450)**
bimaculata (Panzer), 1798 An *(Apis),* P (=*Apis rotundata* Panzer, 1798; =*An. saropoda* Lamarck, 1817; =*An. squalida* Lepeletier, 1841 **n. syn.**; =*An. albifrons* Eversmann, 1852; =*An. cognata* Smith, 1854; =*Heliophila mesasiatica* Popov, 1952 [as *bimaculata* ssp.] *nomen nudum*) **(446, 449, 453, 489–491, 493, 499)**
bimaculifera Walker, see *niveocincta* (Smith)
bimaculosus Dalla Torre, see *niveocincta* (Smith)
binghami (Schulz), 1906 Am (Po), P (n. name for *An. crocea* Bingham, 1897, not Klug, 1845) **(511)**
binotata Lepeletier, see *albigena* (Lepeletier)
bipartita Smith, see *acraensis* (Fabricius)
birkmanni (Cockerell), 1905 Ha *(Emphoropsis)* **n. comb.**, N
bispinosa Cockerell, 1949 An, T **(494)**
bistrigosa Illiger, 1806 *(Megilla) nomen nudum*
bisulca Pérez, 1895 An, P **(496)**
blanda Pérez, 1895 An, P **(476)**
bogdanowi Fedtschenko, 1875 An, P **(466)**
bogutensis (Marikovskaya), 1976 An *(Paramegilla),* P **(476)**
boharti Brooks n. sp. An, P **(438, 466, 468, 532–534, 536)**
boliviensis Friese, see *arequipensis* Brèthes
bombiformis (Smith), 1854 Am *(Saropoda),* A **(450, 496, 513–515, 556)**
bombiomorpha Wu, see *pseudobomboides* (Meade-Waldo)
bomboides Kirby, 1837 An, N (=*An. canadensis* Cresson, 1869; =*An. sodalis* Cresson, 1879 **n. syn.**; =*An. insularis* Smith, 1879 **n. syn.**; =*An. solitaria* Ritsema, 1880 [n. name for *An. insularis* Smith, 1879, not Smith, 1857] **n. syn.**; =*An. neomexicana* Cockerell, 1900 [as *bomboides* ssp.] **n. syn.**; =*An. stanfordiana* Cockerell, 1904 **n. syn.**; =*An. fumipennis* Swenk, 1909 **n. syn.**; =*An. scutellaris Swenk,* 1909 **n. syn.**; =*An. willingi* Cockerell, 1911 [as *bomboides* ssp.]; =*An. raui* Rohwer, 1923 **n. syn.**; =*An. aterrima* Cockerell, 1924 **n. syn.**) **(448, 478)**
bombyformis Smith, see *badia* (Dours)
bombylans Mocsáry, see *garrula* (Rossi)
boops Alfken, see *vidua* (Klug)
borealis Morawitz, 1864 An, P **(466, 468, 478, 489, 534)**
borgensis Priesner, see *zanoni* Gribodo
borneensis (Cockerell), 1910 [as *zonata* ssp.] Am (An), O **(511)**
bothai (Friese), 1911 Am (An), E **(506)**
bouwmani (Lieftinck), 1944 Am (An), O **(513)**
braunsiana Friese, 1905 An, E **(492)**
bremiformis Dalla Torre, see *badia* (Dours)
breviuscula Illiger, 1806 *(Megilla) nomen nudum*
brookiae (Bingham), 1890 Am (An), O **(513)**
bucconis (Friese), 1910 Ha (An), O
bucharica (Gussakovsky), 1935 Am (An), P **(515)**
buruensis (Cockerell), 1911 [as *zonata* ssp.] Am (An), O **(511)**
byssina (Klug), 1845 Am *(Saropoda),* P (=*Po. schmiedeknechti* Friese, 1899 **n. syn.**; =*An. dusmeti* Guiglia, 1933 **n. syn.**; =*An. helouanensis* Priesner, 1957 **n. syn.**) **(510)**
byssina Illiger, 1806 *(Megilla) nomen nudum*
byssinoides Benoist, see *pulverosa* Smith
caelebs Gribodo, 1924 An, P (=*An. alfierii* Alfken, 1942 **n. syn.**) **(464, 466)**
caelestina (Cockerell), 1919 Am (An), E **(506, 558)**
caerulea (Friese), 1905 Am (An), E (=*An. ella* Strand, 1914 [as *coerulea* (sic) ssp.] **n. syn.**) **(506, 548)**
caffra (Friese), 1905 Am (An), E **(515)**
cala Strand, see *calens* (Lepeletier)
calcarata Lepeletier, 1841 An, P **(455, 486)**
calceifera (Cockerell), 1911 Am (An), O (=*An. tainana* Strand, 1913 [as *calceifera* ssp.] **n. syn.**) **(510, 511)**
calceina (Cockerell), see *calens* (Lepeletier)
caldwelli (Cockerell), 1911 Am (An), O **(515)**
calens (Lepeletier), 1841 Am (An), E (=*An. torrida* Smith, 1879; =*An. cala* Strand, 1914 [as *torrida* ssp.] **n. syn.**; =*An. calceina* Cockerell, 1936 [as *torrida* ssp.] **n. syn.**) **(504)**
californica Cresson, 1869 An, N (=*An. tarsata* Dours, 1869 **n. syn.**; =*An. subtarsata* Cockerell, 1904 [as *tarsata* ssp.] **n. syn.**; =*An. texana* Cresson, 1872; =*Po. doursii* Dalla Torre, 1896 [n. name for *An. tarsata* Dours, 1869, not *Tetralonia tarsata* Spinola, 1838] **n. syn.**; =*An. quinquefasciata* Provancher, 1895 [=5-*fasciata* Provancher, 1895]; =*An. erysimi* Cockerell, 1937 [as *californica* ssp.] **n. syn.**; =*An. albomarginata* Timberlake, 1937 [as *californica* ssp.] **n. syn.**) **(448, 450, 454, 478–481, 557)**
californiensis Michener, see *ursina* Cresson
caligata Gerstaecker, see *circulata* (Fabricius)
caliginosa Klug see *robusta* (Klug)
calva (Rayment), 1935 Am (An), A **(515)**
cambouei Saussure, see *micrelephas* Smith
camelorum (Cockerell), 1911 Am (An), P, n. name for *An. ruficornis* Fedtschenko, 1875, not Dours, 1869 **(515)**
cana (Walker), 1871 Am (An), P (=*An. nivosella* Priesner, 1957, female, not male, **n. syn.**) **(515)**
canadensis Cresson, see *bomboides* Kirby
canariensis Saunders, see *alluaudi* Pérez
candens (Pérez), 1879 Am (An), P, n. name for *An. candida* Pérez, 1879, not Smith, 1879 **(515)**
candida Pérez, see *candens* (Pérez)
candida (Smith), 1879 Am (An), PO **(515)**
candidata Gribodo, see *hispanica* (Fabricius)
candidella (Priesner), 1957 Am (An), P **(515)**
candidifrons Cockerell, 1946 An, E **(492)**

canescens Dours, see *lanata* (Klug)
canifronoides Brooks n. sp. Am, P **(438, 510, 546)**
canifrons (Smith), 1854 Am (An), P (=*An. atlantica* Alfken, 1931) **(504, 546)**
capensis (Friese), 1905 Am (An), E (=*An. convolvuli* Cockerell, 1907 **n. syn.**; =*An. natalensis* Friese, 1922 **n. syn.**) **(504, 546, 547)**
capensis Cameron, see *festivus* (Dours)
capeverdensis Brooks n. sp. Am, P **(438, 510, 546, 547)**
capistrata Cresson, 1878 An, NT **(453, 466, 468, 469, 479)**
carbonaria Cresson, see *pacifica* Cresson
carbonaria Morawitz, see *dubia* Eversmann
cardui (Cockerell), see *montana* Cresson **(556)**
carinifrons Cameron, 1903 (Ha) = *Thygater dispar* (Smith), 1854 (Anthophoridae; Eucerini) according to Urban, 1967
carinulata Morawitz, 1886 An (An), P **(482)**
carnea Gribodo, see *erubescens* Morawitz
caroli Pérez, 1895 An, P **(464)**
catalinae Cockerell, see *urbana* Cresson
caucasica Radoszkowsky, see *biciliata* Lepeletier
caucasicola Hedicke, see *furcata* (Panzer)
caucasicus Friese, see *furcata* (Panzer)
cellularis Cameron, 1898 Un (An), O **(450)**
centralis (Cockerell), 1930 Am (An), E **(515)**
centriformis Cresson, 1879 An, N (=*An. abruptella* Cockerell, 1906 [dark form]; =*An. vierecki* Cockerell, 1906 [as *centriformis* ssp.]) **(443, 445, 472, 476)**
centuncularis Zetterstedt, 1838 (An) =*Megachile* (Megachilidae)
cerberus Friese, see *dubia* Eversmann
cerealis (Cockerell), 1933 Am (An), E **(504)**
chalcites Illiger, 1806 *(Megilla) nomen nudum* = *Ceratina chalcites* Germar, 1839, according to Daly, 1983 (Anthophoridae; Ceratinini)
chilensis Spinola, 1851 (An) =*Diadasia* (Anthophoridae; Emphorini)
chinensis Friese, 1919 [as *fulvitarsis* ssp.] An, O **(460)**
chloris Fabricius, see *metallica* Fabricius
chlorocyanea (Cockerell), 1914 Am (An), A (=*An. tinsleyella* Rayment, 1944 **n. syn.**, publication date is not 1942; =*An. luteola* Rayment, 1944 **n. syn.**, publication date is not 1942) **(511, 512, 520)**
chlorops Michener, see *porterae* Cockerell
chodjana Hedicke, see *plagiata* (Illiger)
christofi Morawitz, 1880 An, P **(476)**
chromatica Cockerell, see *rufolanata* Dours
chrysopoda (Illiger), see *subterranea* Germar
ciliatus Friese, see *ocularis* (Saussure)
cincreus (Friese), 1896 An (Po), P (=*Po. cinereus* Friese, 1897, invalid emendation) **(464)**
cincta of Dours, see *fabriciana* (Rayment)
cincta (Fabricius), 1781 Am *(Andrena)*, E (=*An. vividula* Strand, 1910; =*An. lisalana* Cockerell, 1930 [as *cincta* ssp.] **n. syn.**) **(506)**
cinctofemorata (Dours), 1869 Am (An), O **(511)**
cineraria (Smith), 1879 Ha (An) **n. comb.**, N
cinerascens Lepeletier, 1841 An, E (=*An. hypopolia* Dours, 1869; =*An. stschurovskyi* Fedtschenko, 1875) **(466)**
cinerea Eversmann, see *podagra* Lepeletier
cinereiceps Alfken, see *nigrilabris* Spinola
cinereus Friese, see *cincreus* (Friese)
cinerior Cockerell, see *usticauda* Cockerell
cinerithoracis Wu, 1982 An, P **(478)**
cingulata (Fabricius), 1775 Am *(Apis)*, A (=*An. emendata* Smith, 1879; =*An. gilberti* Cockerell, 1905 [as *emendata* ssp.] **n. syn.**; =*An. lilacine* Cockerell, 1921 **n. syn.**; =*An. lilacina* (sic) Cockerell, 1922) **(511)**
cingulicauda Cockerell, see *mimadvena* Cockerell
cingulifera (Cockerell), 1910 Am (An), O **(497, 511)**
cinnyris (Lieftinck), 1944 Am (An), O **(513)**
circulata (Fabricius), 1781 Am *(Andrena)*, E (=*Megilla caligata* Gerstaecker, 1871 and described as new again in 1873; =*An. facialis* Friese, 1922 [as *circulata* ssp.] **n. syn.**; =*An. malelana* Cockerell, 1946 **n. syn.**) **(502, 504)**
cirrhosa Pérez, see *incerta* Spinola
citreostrigata Dours, 1869 Un (An), N **(450)**
citula (Cockerell), 1929 Ha *(Emphoropsis)* **n. comb.**, N
clavatipes Priesner, see *extricata* Priesner
clavicornis Fedtschenko, 1875 An, P **(450, 476)**
claviger Benoist, 1962 *Pachymelus*, E
clementina Cockerell, see *urbana* Cresson
cleomis Cockerell, see *marginata* Smith **(555)**
clessini Fedtschenko, 1875 An, P **(462, 466)**
clitelligera Friese, see *armata* Friese
cockerelli Timberlake, 1937 An, N **(450, 494, 496)**
cognata Smith, see *bimaculata* (Panzer)
coloradensis Michener, see *edwardsii* Cresson
columbariae Timberlake & Cockerell, 1937 An, N **(494, 496)**
comberi (Cockerell), 1911 Am (An), O **(450, 511)**
combusta Dours, 1869 Un (An), P **(450)**
comperei Cockerell, see *acraensis* (Fabricius)
concinna (Klug), 1845 An *(Megilla)*, P **(492)**
concolor Alfken, 1926 An, P **(476)**
confusa (Smith), 1854 Am (An), O **(504)**
congoensis Friese, see *nubica* (Lepeletier)
conica Packard, 1864 (An) =*Centris* (Anthophoridae; Centridini)
conica Illiger, 1806 Un (An), P
connexiformis Cockerell, 1917 An, O **(464)**
connexus Nurse, see *sichelii* Radoszkowsky
conoidea Illiger, 1806 (An) =*Coelioxys* (Megachilidae) according to Gerstaecker, 1869
conradsi Strand [as *vividula* ssp.] (An), E, listed in Cockerell, 1930, but original description not found
conspicuus Smith, 1879 *Pachymelus*, E (=*Pachymelus insulanus* Stadelmann, 1898 **n. syn.**; =*Ha. bettoni* Cockerell, 1910 **n. syn.**; =*An. armatipes* Friese, 1911) **(447)**
convolvuli Cockerell, see *capensis* (Friese)
coptognatha Timberlake, 1951 An, N **(466)**
corvicolor Cockerell, see *pacifica* Cresson
costaricensis (Friese), 1916 *Deltoptila* (An), T
crassipes Lepeletier, 1841 An, P (=*An. quadristrigata* Dours, 1869 **n. syn.**; =*An. dentricrus* Morawitz, 1872; =*An. perplexa* Radoszkowsky, 1884) **(484, 486)**
cressonii (Dalla Torre), 1896 Ha (Po) **n. comb.**, N, n. name for *An. mucida* Cresson, 1878, not Gribodo,

1873 (=*Emphoropsis johnsoni* Cockerell, 1905 [as *mucida* ssp.]; =*An. ventralis* Michener, 1936 [as *mucida* ssp.])
crinipes Smith, see *salviae* (Panzer) **(457, 460)**
crocea Bingham, see *binghami* (Schulz)
crocea (Klug), 1845 Am *(Megilla),* EP **(504)**
croceipes Morawitz, see *larvata* Giraud
croceitarsis Gussakovsky, 1935 An, P **(496)**
crotchii Cresson, 1878 An, N (=*An. washingtoni* Cockerell, 1905) **(445, 460–462)**
crysocnemis Morawitz, 1878 An, P (=*Po. chrysocnemis* (sic) Dalla Torre, 1896, and Friese, 1897) **(482)**
cuneata Cockerell, see *mimadvena* Cockerell
cunicularia Friese, 1914 An, E **(486)**
curta Provancher, see *squammulosa* Dours **(489)**
curvicornis Hedicke, 1940 An, P **(476)**
custos (Dalla Torre), 1896 Am (Po), O, n. name for *An. vigilans* Smith, 1878, not Smith, 1860 (=*An. mcnamarae* Cockerell, 1929 [as *vigilans* ssp.] **n. syn.**) **(511)**
cyaneotincta Cockerell, see *quadrata* (Cockerell)
cyanicollis Friese, see *acraensis* (Fabricius)
cyanipennis (Saussure), 1890 Am (An), E **(506)**
cygni (Rayment), 1931 Am (An), A **(515)**
cypriaca Mavromoustakis, see *plumipes* (Pallas)
cyrenaica Gribodo, see *hispanica* (Fabricius)
cyrtandrae (Lieftinck), 1944 Am (An), O **(513)**
dalmatica Pérez, 1902 An, P (=*An. agamoides* Strand, 1915 [as *agama* ssp.] **n. syn.**) **(462)**
dalmatiensis Strand, 1916 Un (An), P, n. name for *An. subterranea* Gistel, 1857, not *An. subterranea* Germar, 1826 **(450)**
dammersi Timberlake, 1937 An, N **(464–466)**
dammersi (Timberlake), 1937 Ha *(Emphoropsis)* **n. comb.**, N
darwini Cockerell, see *walkeri* (Cockerell)
dawsoni (Rayment), 1951 Am (An), A **(513, 515)**
deceptrix (Priesner), 1957 Am (An), P **(492)**
decrepita Illiger, see *subterranea* Germar
deiopea (Cameron), 1897 Ha (An), O
delicata Cockerell, see *mucorea* (Klug)
deltoides (Buysson), 1897 Am (An), P **(515)**
dentata Rayment, see *rubricata* (Rayment)
dentilabris Morawitz, 1894 An, P **(496)**
dentipes Illiger, see *podagra* Lepeletier
dentiventris (Rayment), 1951 Am *(Asaropoda),* A **(515)**
dentricrus Morawitz, see *crassipes* Lepeletier
depressa Fowler, 1899 Ha, N
deserticola Morawitz, 1873 An, P **(474–476)**
desertorum Gussakovsky, 1935, An, P **(496)**
desertorum Priesner, see *arida* Brooks
determinata Friese, see *reichardti* Stadlemann
diloloensis (Cockerell), 1932 Am (An), E **(504)**
dimidiata Alfken, see *plumipes* (Pallas)
dimidiozonata Dours, see *sichelii* Radoszkowsky
disconota Lieftinck, 1974 Ha, O
dispar Lepeletier, 1841 An, P (=*An. speciosa* Friese, 1919 [as *dispar* ssp.] **n. syn.**; =*An. niveohirta* Friese, 1922 [as *dispar* ssp.] **n. syn.**) **(462, 464, 465)**
disparilis Friese, 1922 An, P (=*An. bicalcarata* Hedicke, 1936 **n. syn.**) **(464–466)**
disrupta (Cockerell), 1920 Am (An), E **(504)**
distinguenda Spinola, 1851 (An) =*Diadasia* (Anthophoridae; Emphorini)
diversipes Friese, 1922 An, E (=*An. fulleri* Brauns, 1929 **n. syn.**) **(462)**
dives Dours, see *dufourii* Lepeletier
dohertyi (Gribodo), 1894 Am (An), O **(510, 511)**
domicola (Cockerell), see *atrocincta* (Lepeletier)
domingensis Lepeletier, see *maculicornis* (Lepeletier)
dorsalis Vachal, 1909 An, T (=*An. ecuadoria* Friese, 1922 **n. syn.**; =*An. trichroma* Friese, 1925 **n. syn.**; =*An. incerta* Janvier, 1955 **n. syn.**) **(468)**
dorsimacula Dufour, see *quadricolor* (Erichson)
doursiana (Friese), 1897 An (Po) (=*An. ventilabris* of Dours, 1869, not Lepeletier, 1841) **(496)**
doursii Dalla Torre, see *californica* Cresson
doveri Cockerell, see *zonata* (Linnaeus)
drewsenii Sichel, see *rufolanata* Dours
dubia Eversmann, 1852 An, P (=*An. saussurei* Fedtschenko, 1875; =*An. semperi* Fedtschenko, 1875; =*An. faddei* Radoszkowsky, 1882; =*An. albomaculata* Radoszkowsky, 1874; =*An. carbonaria* Morawitz, 1876 **n. syn.**; =*An. cerberus* Friese, 1919 [as *semperi* ssp.] **n. syn.**) **(473, 476)**
dufourii Lepeletier, 1841 An, P (=*An. tecta* Smith, 1854, type locality of *tecta* is not the New World as in description but probably southern France from color form of type; =*An. dives* Dours, 1869; =*An. nigropyga* Strand, 1921 [as *dufouri* (sic) ssp.] **n. syn.**; =*An. fasciculipes* Alfken, 1935 **n. syn.**) **(438, 470, 471, 489)**
dulcifera (Cockerell), 1926 Am (An), O, (=*An. senahai* Yasumatsu, 1935 [as *cingulata* ssp.]; =*An. subflavescens* Yasumatsu, 1965 [as *senahai* ssp.] **n. syn.**) **(511)**
dumetorum Panzer, see *furcata* (Panzer)
duplicicornis Illiger, 1806 *(Megilla) nomen nudum*
dusmeti Guiglia, see *byssina* (Klug)
eburnea Radoszkowsky, 1876 An, P **(472, 476)**
ecuadoria Friese, see *dorsalis* Vachal
edwardsii Cresson, 1878 An, N (=*An. gohrmanae* Cockerell, 1903 **n. syn.**; =*An. coloradensis* Michener, 1936 [as *gohrmanae* ssp.] **n. syn.**) **(460–462, 488)**
effossa Heyden, 1862 Un (An), P (fossil; it is impossible to be sure that this is a species of An. [Zeuner and Manning, 1976]) **(524)**
ekuivensis Cockerell, 1908 An, E **(492)**
elbana Priesner, 1957 An, P **(492)**
elefas (Friese), 1916 *Deltoptila* (An), T
elegans (Smith), 1859 Am (An), O **(511)**
elephas (Lieftinck), 1944 Am (An), O **(513)**
elgonica (Cockerell), 1946 Am (An), E **(504)**
elimata Cockerell, 1933 An, E (=*An. infracana* Cockerell, 1933 **n. syn.**) **(492)**
ella Strand, see *caerulea* Friese
elsei Brooks n. sp. Am, E **(438, 506, 548, 549)**
emarginata Timberlake, see *rhodothorax* Michener
emendata Smith, see *cingulata* (Fabricius)
ensenadensis Cockerell, see *squammulosa* Dours
epaphrodita Brooks n. sp., Am, A **(438, 515, 553–555)**
epeolina Illiger, 1806 (An) =*Ammobates vinctus* Gerstaecker, 1869, according to Gerstaecker, 1869
ephippium Lepeletier, see *salviae* (Panzer)

epichariformis Gribodo, 1893 An, E (=*An. superba* Friese, 1911 **n. syn.**; =*An. leucospila* Cockerell, 1936 **n. syn.**) **(476)**
eritrea Brooks An, P, n. name for *Antophora (sic) flaviventris* Friese 1915, Deutsche Entomol. Zeitschr. 1915:289-290, not Friese, 1896 **(492)**
eritrina (Friese), 1915 Am (An), E **(504)**
ernesti Rayment, see *adelaidae* (Cockerell)
erratica (Lieftinck), 1944 *Elaphropoda* (Ha), O
erschowi Fedtschenko, 1875 An, P **(460, 462)**
erubescens Morawitz, 1880 An, P (=*An. carnea* Gribodo, 1894) **(472)**
erysimi Cockerell, see *californica* Cresson
erythrothorax Michener, 1936 An, N **(496)**
escomeli Brèthes, see *arequipensis* Brèthes **(468)**
estebana Cockerell, 1923 An, N **(494, 496)**
eugeniae Gussakovsky, 1935 An, P **(492)**
euops Cockerell, see *ursina* Cresson
euris Dours, see *fulvitarsis* Brullé
eversa Cockerell, 1911 An, O **(496)**
eversmanni Radoszkowsky, see *senilis* Eversmann
eversmannii (Dalla Torre & Friese), 1895 An (Po), P, n. name for *An. quadricincta* Eversmann, 1852, not Fabricius, 1798 **(462)**
excellens (Timberlake), 1962 Ha *(Emphoropsis)* **n. comb.**, N
excelsa Fedtschenko, see *excelsior* Strand
excelsa Gistel, 1857 Un *(Megilla)*, P **(450)**
excelsior Strand, 1916 Un *(Megilla)*, P, n. name for *An. excelsa* Fedtschenko, 1875, not *Megilla excelsa* Gistel, 1857 **(450, 476)**
excisa Morawitz, 1894 An, P **(450, 456, 486, 489, 517)**
exigua Cresson, 1879 An, N **(494, 496)**
expleta (Vachal), 1910 Am (An), E **(515)**
extricata Priesner, 1957 An, P (=*An. clavatipes* Priesner, 1957 [as *extricata* spp.] **n. syn.**) **(486)**
ezonata Smith, see *tarsata* (Spinola)
fabriciana (Rayment), 1947 Am (An), A, n. name for *An. cincta* of Dours, 1869, not Fabricius, 1781 **(511)**
facialis Priesner, see *facialoides* Brooks
facialis Friese, see *circulata* (Fabricius)
facialoides Brooks An, P, n. name for *An. facialis* Priesner, 1957, Bull. Soc. Entomol. Egypte 41:47, not Friese, 1922. The holotype male has the following data: Wadi Umm Assad, 18-3-35, Dr. H. Priesner/Holotype [red label]/facialis Type, det. H. Priesner. Now known as Wādī Umm As'ad, 29°54'N, 31°34'E and holotype in the collection of M. Schwarz, Ansfelden, Austria **(464).**
faddei Radoszkowsky, see *dubia* Eversmann
fallaciosa Priesner, 1957 An, P **(492)**
fallax (Smith), 1879 Am (An), P **(504)**
farinosa (Klug), 1845 Am *(Megilla)*, EP (=*An. persicorum* Cockerell, 1910 **n. syn.**) **(505, 557)**
farinosa Alfken, see *quadrifasciata* (de Villers)
fasciata Alfken, see *retusa* (Linnaeus)
fasciata (Fabricius), 1775 Am *(Andrena)*, P **(510)**
fasciculipes Alfken, see *dufourii* Lepeletier
fastuosa Gribodo, see *albosignata* Friese
fayoumensis Priesner, 1957 An, P **(492)**
fedorensis Cockerell, see *laboriosa* (Fabricius)
fedorica Cockerell, 1906 An, N **(466)**
fedchenkoi Radoszkowsky, 1872 An, P (=*An. fedtschenkoi* Radoszkowsky, 1893; it appears that the spelling of *fedchenkoi* is what Radoszkowsky originally intended, even though he spells his name "Fedtchenko" on the page opposite the description. He apparently changed his mind and emended his original latinization invalidly to *fedtschenkoi* in 1893. This emendation has been followed by all subsequent workers) **(474, 476)**
felina (Friese), 1911 Am (An), E (=*An. leopoldi* Cockerell, 1933) **(504)**
femorata (Olivier), 1789 An *(Apis)*, P (=*An. solitaria* Radoszkowsky, *nomen nudum* by Friese 1909) **(470, 474, 476)**
ferghanensis Gussakowsky, 1935 An, P **(496)**
feronia (Lieftinck), 1944 Am (An), O **(513)**
ferreola Cockerell, 1931 An, O **(478)**
ferripicta Cockerell, 1935 [as *natensis* ssp.] An, E **(492)**
ferrisi (Rayment), 1947 Am (An), A **(511)**
ferrocincta (Cockerell), 1936 Am (An), E **(504)**
ferruginata Lepeletier, 1841 Un (An), P **(450)**
ferruginea Lepeletier, 1841 An, P (=*Po. alboferrugineus* Friese, 1896 [as *ferrugineus* ssp.]) **(472, 474, 476)**
festae Gribodo, 1924 An, P **(462)**
festivus (Dours), 1869 *Pachymelus* (Ha) **n. comb.**, E (=*Ha. tomentosa* Friese, *nomen nudum* by Friese, 1903 and 1909; =*Ha. capensis* Cameron, 1905 **n. syn.**; =*Po. malenominatus* Schulz, 1906 [n. name for *capensis* Cameron, 1905, not Friese, 1905] **n. syn.**)
filchnerae Friese, see *plagiata* (Illiger)
fimbriata (Smith), 1879 Am (An), O **(513)**
finitima Morawitz, 1894 An, P **(464)**
fixseni Morawitz, 1876 An, P **(496)**
flabellata Priesner, 1957 An, P **(462)**
flabellifera Lepeletier, see *pubescens* (Fabricius)
flabellipes Lichenstein, see *pubescens* (Fabricius)
flammeozonata (Dours), 1869 [as *zonata* ssp.] Am (An), O **(511)**
flava Friese, see *scymna* Gribodo
flavescens Fedtschenko, 1875 An, P **(476)**
flavescens Gribodo, see *subterranea* Germar
flaviceps Friese, see *niveocincta* (Smith)
flavicollis Gerstaecker, see *acraensis* (Fabricius)
flavicornis Morawitz, 1886 An, P **(476)**
flavipes Hedicke [as *parietina* ssp.] listed by Alfken, 1935 but original description not found
flavipes Sichel, 1867 (An) =*Svastra flavitarsis* (Spinola), 1851 (Anthophoridae; Eucerini)
flavithorax Benoist, see *ocularis* (Saussure)
flaviventris Friese, see *orientalis* Morawitz
flaviventris Friese, see *eritrea* Brooks
flavocincta Huard, 1897 An, N, n. name for *An. nigrocincta* Provancher, 1895, not Lepeletier, 1841 (=*An. anstrutheri* Cockerell, 1906) **(494, 496)**
flavofimbriata Hedicke, 1931 [as *bimaculata* ssp.] An, P **(492)**
fletcheri Cockerell, see *magrettii* (Bingham)
flexipes Cresson, 1879 An, N **(489, 494, 496)**
florea (Smith), 1879 Am (An), O (=*An. tsushimensis* Cockerell, 1926 **n. syn.**) **(449, 513)**
floridana Smith, see *laboriosa* (Fabricius)

footei Crawford, 1914 An, T **(466, 468)**
forbesi Cockerell, 1907 An, N **(460, 462)**
franciscana Cockerell, 1949 An, T **(496)**
fratercula Gribodo, 1924 An, P **(466)**
fraterna Bingham, 1897 An, O **(490–492)**
freimuthi Fedtschenko, 1875 An, P (=*An. oschanini* Fedtschenko, 1875; =*An. gertali* Radoszkowsky, *nomen nudum* by Friese, 1909) **(496)**
froggatti Cockerell, see *preissi* (Cockerell)
frontata Say, 1837 Un (An), N **(450)**
fuerteventurae Lieftinck, see *alluaudi* Pérez
fuliginosa Illiger, see *quadrifasciata* (de Villers)
fuliginosa Morawitz, 1894 An, P **(466, 557)**
fulleri Brauns, see *diversipes* Friese
fulva (Smith), 1879 *Deltoptila* (Ha), T
fulva Eversmann, 1852 *(Saropoda)* =*Epeoloides coecutiens* (Fabricius), 1775 (Anthophoridae; Epeoloidini)
fulvata Fabricius, 1804 *(Megilla)* =*Nomia* (Halictidae)
fulvicauda Timberlake, 1937 An, N **(450, 476, 479)**
fulvicollis Timberlake, see *affabilis* Cresson
fulvifrons Smith, see *taurea* (Say)
fulvipes Cameron, see *khasiana* Schulz
fulvipes Eversmann, 1846 An, P **(476)**
fulviscopa Alfken, see *semirufa* Friese
fulvitarsis Brullé, 1832 An, P, (=*Megilla personata* Illiger, 1806, *nomen nudum;* =*An. nasuta* Lepeletier, 1841; =*An. arietina* Dours, 1869; =*An. euris* Dours, 1869 [as *personata* ssp.]) **(457, 460, 556, 558)**
fulvitecta Kirby, see *inclyta* Walker
fulviventris Zetterstedt, 1838 (An) =*Megachile* (Megachilidae)
fulvocinerea Dours, see *plagiata* (Illiger)
fulvodimidiata Dours, 1869 An, P **(491, 492)**
fulvohirta Meade-Waldo, see *insularis* (Smith)
fumipennis Alfken, see *vidua* (Klug)
fumipennis Swenk, see *bomboides* Kirby
furcata (Panzer), 1798 An *(Apis),* P (=*Apis dumetorum* Panzer, 1798; =*Megilla norvegica* Nylander, 1852 [as *furcata* ssp.] **n. syn.;** =*Po. caucasicus* Friese, 1897 [as *furcatus* ssp.] **n. syn.;** =*Po. montislinguarum* Schulz, 1906 [as *furcatus* ssp. and n. name for *Po. caucasicus* Friese, 1897, not *An. caucasica* Radoszkowsky, 1874] **n. syn.;** =*An. atrata* Hedicke, 1929 [as *furcata* ssp.] **n. syn.;** =*An. caucasicola* Hedicke, 1929 [as *furcata* ssp.] **n. syn.;** =*An. obscurella* Alfken, original description not found) **(487–489)**
furcotibialis Wu, 1985 An, O **(476)**
fuscipennis Smith, 1854 (An), N, =*Melissodes bimaculata* (Lepeletier), 1825 **n. syn.** (Anthophoridae; Eucerini)
galalensis Priesner, 1957 An, P **(492)**
gallica Dalla Torre & Friese, see *quadricolor* (Erichson)
garrula (Rossi), 1790 Am *(Apis),* P (=*An. bombylans* Mocsáry, 1879) **(504, 505)**
gayi Spinola, 1851 (An) =*Eucerinoda gayi* (Spinola) (Anthophoridae; Eucerinodini)
gedzeni Radoszkowsky, see *glasunovi* Morawitz
gemella Morawitz, 1878 An, E **(492)**
germabica Radoszkowsky, 1893 Un (An), P **(450)**
gertali Radoszkowsky, see *freimuthi* Fedtschenko
ghigii Gribodo, 1924 An, P **(464)**
gigantea Friese, see *hirtiventris* Friese
gigas (Friese), 1922 Am (An), O **(513)**
gilberti Cockerell, see *cingulata* (Fabricius)
glasunovi Morawitz, 1894 An (=*An. gedzeni* Radoszkowsky, *nomen nudum* by Friese, 1909) **(476)**
glauca Alfken, see *andresi* (Friese)
glaucopis Friese, 1905 An, E **(476)**
globosa Fabricius, 1793 *(Apis),* T, =*Exomalopsis* (Anthophoridae; Exomalopsini)
glycyrrhizae (Gussakovsky), 1935 Am (An), P **(511)**
godofredi (Dours), 1869 Am (An), E (=*An. modesta Smith,* 1879 **n. syn.) (508, 510, 551, 556)**
gohrmanae Cockerell, see *edwardsii* Cresson
gracilipes Morawitz, 1873 An, P **(452, 473–476, 489)**
graeca (Alfken), 1942 Am (An), P **(504)**
grandiceps (Friese), 1905 Am (An), E (=*An. leucophora* Cockerell, 1910 **n. syn.;** =*An. semigrisea* Cockerell, 1930 **n. syn.) (502, 504)**
grandidieri Cockerell, see *heydenii* Saussure
grandis Lepeletier, see *hispanica* Fabricius
grayella (Rayment), 1944 Am (An), A, publication date is not 1942 **(512)**
greyae Cockerell, see *vestita* Smith
grisea Christ, see *pubescens* (Fabricius)
grisea Schletterer, 1890 (An) =*Svastrides melanura* (Spinola), 1851 (Anthophoridae; Eucerini)
grisea Fabricius, 1804 (An) =*Halictus* (Halictidae), not *Apis grisea* Fabricius, 1794
grisella (Cockerell), see *obscuriceps* (Friese)
griseotecta (Cockerell), 1946 Am (An), E **(508)**
griseovestita Cockerell, see *vestita* Smith
grisescens (Rayment), 1931 Am (An), A **(515)**
grisescens Ducke, 1907 (Po) =*Melitoma* (Anthophoridae; Emphorini)
guachalae Cameron, see *pilifrons* Packard
guigliae Dusmet, see *rivolleti* Pérez
guinea (Strand), 1912 [as *vivida* ssp.] Am (An), E **(506, 558)**
gussakovskyi (Popov), 1946 Am (An), E, n. name for *An. pygmaea* Gussakovsky, 1935, not Dours, 1869 **(515)**
habropodoides Dalla Torre, see *aurulentocaudata* (Dours)
hackeri (Rayment), 1947 Am (An), A **(511)**
haefligeri Friese, 1905 (An) =*Eucara* (Anthophoridae; Eucerini)
hanitschi (Meade-Waldo), 1914 Am (An), O **(513)**
hanseni Morawitz, 1883 An, P **(484, 486)**
harmalae Morawitz, 1878 An, **(476)**
harttigi (Alfken), 1926 Am (An), P **(504)**
hastula Vachal, 1909 Un (An), E **(450)**
haworthana Kirby, see *retusa* (Linnaeus)
hedini Alfken, 1936 An, O (=*Heliophila latitarsalis* Wu, 1985 **n. syn.) (470)**
hegasica Priesner, 1957 [as *concinna* ssp.] An, P **(492)**
heinemanni Fedtschenko, 1875 An, P (=*An. hilgendorfi* Cockerell, 1911 **n. syn.) (466)**
heliopolitensis Pérez, 1910 An, P **(496)**
helouanensis Priesner, see *byssina* (Klug)
hemithoracica Sichel, see *acraensis* (Fabricius)
herbsti Friese, see *ruficaudis* Cameron
heteropoda Cockerell, see *xanthostoma* Cockerell
heydenii (Saussure), 1890 *Pachymelus* (Ha) **n. comb., E** (=*Pachymelus grandidieri* Cockerell, 1916 **n. syn.**) **(558)**
hilaris Smith, 1879 An, T **(468, 469)**

hilgendorfi Cockerell, see *heinemanni* Fedtschenko
himalajensis (Radoszkowsky), 1882 Am (An), O (=*An. proserpina* Gribodo, 1893; =*An. pahangensis* Meade-Waldo, 1914 [as *himalayensis* (sic) ssp.] **n. syn.**) **(512, 513)**
himalayaensis Wu, see *plagiata* (Illiger)
hirpex Vachal, see *paranensis* Holmberg
hirsuta Fabricius, see *plumipes* (Pallas)
hirtiventris Friese, 1911 An, E (=*An. gigantea* Friese, 1913 **n. syn.**, and described as new again later the same year) **(476)**
hispanica (Fabricius), 1787 An *(Apis),* P (=*An. grandis* Lepeletier, 1841; =*An. rypara* Dours, 1869; =*An. candidata* Gribodo, 1893 [as *hispanica* ssp.] **n. syn.**; =*An. cyrenaica* Gribodo, 1924 [as *hispanica* ssp.] **n. syn.**) **(464–466)**
histrio Illiger, 1806 (An) *nomen nudum,* =*Pasites maculatus* Jurine, 1807, according to Gerstaecker, 1869
histrio Dours, see *marginata* Smith
holmesi (Rayment), 1947 Am (An), A **(511)**
hololeuca Cockerell, 1923 An, N **(451, 489, 494–496)**
holopyrrha Dours, 1869 (An) =*Xenoglossa fulva* Smith, 1854 (Anthophoridae; Eucerini)
holoxantha Pérez, 1895 An, P (=*An. mercetiana* Vachal, 1910 **n. syn.**) **(460, 462)**
honorata Cockerell, see *rufolanata* Dours
hookeri Cockerell, 1920 Ha, O
hortensis Morawitz, 1886 An, P **(489, 496)**
houstoni Brooks n. sp., Am, A **(438, 515, 553–555)**
hova (Saussure), 1890 *Pachymelus* (Ha) **n. comb.**, E (=*Pachymelus meleagrus* Gribodo, 1893 **n. syn.**; =*Pachymelus obscurus* Friese, 1922 [as *howa* (sic) ssp.] **n. syn.**)
humilis (Spinola), 1838 An *(Saropoda),* P (=*An. albocinerea* Saunders, 1904 **n. syn.**) **(492)**
hypocyanea (Cockerell), 1930 Am (An), E **(515)**
hypopolia Dours, see *cinerascens* (Lepeletier)
ignava Cresson, see *pacifica* Cresson
illepida Walker, 1871 Un An, P **(450)**
imitata (Rayment), 1951 Am *(Asaropoda),* A **(515)**
imitatrix Cockerell, 1914 Un (An), P, n. name for *An. soror* Pérez, 1910 (from Syria and Russia), not Pérez, 1905 (from Japan) **(450)**
imitatrix Lieftinck, 1974 Ha, O (=*Ha. zhejiangensis* Wu, 1983 **n. syn.**)
impatiens (Lieftinck), 1944 *Elaphropoda* (Ha), O
incana (Klug), 1845 Am (An), P **(505)**
incerta Spinola, 1851 An, T (=*An. cirrhosa* Pérez, 1911) **(446, 468)**
incerta Janvier, see *dorsalis* Vachal **(468)**
incisa Fourcroy, 1785 Un *(Apis),* P **(450)**
inclyta Walker, 1871 An, OP (=*An. fulvitecta* Kirby, 1900; =*An. rufiventris* Friese, 1911 **n. syn.**) **(476)**
indica Radoszkowsky, see *sesquicincta* (Erichson & Klug)
inermis Zetterstedt, 1838 (An) =*Osmia (Megachilidae)*
infernalis Dalla Torre, see *pacifica* Cresson
infracana Cockerell, see *elimata* Cockerell
⊥-insignita Strand, see *insignita* Brooks
insignita Brooks, Am, O, n. name for *An. ⊥-insignita* Strand, 1913, Arch. Naturges. 79:107-108, since the specific name contains a non-Latin symbol, thus invalid under Article 11b of the Code of Zool. Nomen. **(511)**
insulanus Stadelmann, see *conspicuus* Smith
insularis (Smith), 1857 Am (An), O (=*An. fulvohirta* Meade-Waldo, 1914) **(513)**
insularis Smith, see *bomboides* Kirby
intermedia Lepeletier, see *retusa* (Linnaeus) **(556)**
intermixta Alfken, see *plumipes* (Pallas)
intermixta Gribodo, see *intricata* Gribodo
interspersa Cockerell, see *peritomae* Cockerell
interspersa Cockerell, see *tristissima* Cockerell
intricata Gribodo, 1924 An, P (=*An. intermixta* Gribodo, 1924 **n. syn.**, not Alfken, 1913) **(486)**
ioidea Dours, see *senescens* Lepeletier
iole Bingham, 1898 An, PO (=*Heliophila unispina* Wu, 1982 **n. syn.**) **(470)**
ipomoeae Ducke, 1907 (Po) =*Melitoma* (Anthophoridae; Emphorini)
iranica Hedicke, 1940 Un, P **(450)**
ireos (Pallas), 1773 An *(Apis),* P (=*An. lepida* Eversmann, 1846) **(470, 472, 474–476, 484)**
irregularis Dours, 1869 An, P **(476)**
jacobi (Lieftinck), 1944 Am (An), O **(513)**
jakobsoni Kuznetzov-Ugamsky, 1927 Un (An), P **(450)**
jamesi (Rayment), 1944 [as *tinsleyella* spp.] Am (An), A, publication date is not 1942 **(512)**
joetta Brooks n. sp., An, E **(438, 492, 540–543)**
johnsoni Cockerell, see *cressonii* (Dalla Torre)
kaimosica (Cockerell), 1946 Am (An), E **(504)**
karakumensis (Gussakovsky), 1935 Am (An), P **(515)**
katangensis (Cockerell), 1930 Am (An), E **(515)**
kaufmanni Fedtschenko, 1875 An,P **(476)**
kazabi Banaszak, 1984 An, P **(496)**
kessleri Fedtschenko, see *agama* Radoszkowsky
khambana Cockerell, see *plagiata* (Illiger)
khasiana (Schulz), 1906 *Elaphropoda* (Po), O, n. name for *Ha. fulvipes* Cameron, 1904, not *An. fulvipes* Eversmann, 1846
kigomensis Cockerell, 1938 An, E **(492)**
kigonserana Friese, 1905 An, E **(492)**
klugi Priesner, see *quadrifasciata* (de Villers)
kneuckeri Alfken, 1938 An, P **(470)**
kochi Fedtschenko, 1875 An, P **(466)**
kodrokonis Cockerell, 1946 An, E **(492)**
korotonensis (Cockerell), 1911 Am (An), O (=*An. anpingensis* Strand, 1913 [as *korotonensis* ssp.] **n. syn.**) **(511)**
krebsi Friese, see *rufolanata* Dours **(492)**
krishna Bingham, 1908 Ha, O (=*Ha. apatelia* Lieftinck, 1974)
kristenseni Friese, 1915 [as *ampliceps* ssp.] An, P **(492)**
kronebergi Fedtschenko, 1875 An, P **(496)**
krugii Cresson, see *tricolor* (Fabricius)
kuzini Kuznetzov-Ugamsky, 1927 Un (An), P **(450)**
kuznetzovi Cockerell, see *romandii* Lepeletier
laboriosa (Fabricius), 1804 Ha *(Bombus)* **n. comb.**, N (=*An. floridana* Smith, 1854; =*Emphoropsis fedorensis* Cockerell, 1905 [as *floridana* ssp.] **n. syn.**)
labronigro Lebedev, see *pubescens* (Fabricius) **(439)**
labrosa Friese, 1911 An, E **(492)**
lacteifrons Hedicke, 1931 An, P **(486)**
ladakhana Hedicke, see *plagiata* (Illiger)
laevigata Spinola, 1808 Un (An), P **(450)**

lanata (Klug), 1845 An *(Megilla),* P (=*An. canescens* Dours, 1869 [as *senescens* ssp.] **n. syn.**; =*An. venerabilis* Cockerell, 1911 **n. syn.**) **(457, 460)**
lanata Fabricius, 1775 *(Apis)* =Megachile (Megachilidae)
langi (Cockerell), 1935 Am (An), E **(502)**
larvata Giraud, 1863 An, P (=*An. croceipes* Morawitz, 1876 **n. syn.**) **(474, 476)**
lata (Cameron), 1905 *Pachymelus* (Ha) **n. comb.**, E
laticeps Friese, 1905 (An) =*Eucara* (Anthophoridae; Eucerini)
laticeps Friese, see *vestita* Smith
laticincta Dours, 1869, see *subterranea* Germar **(555)**
latigena Morawitz, 1886 An, PO (=*An. reinigi* Hedicke, 1931) **(482)**
latipes Friese, see *atrocincta* Lepeletier
latitarsalis Wu, see *hedini* Alfken
latizona (Spinola), 1838 Am *(Saropoda),* P **(510)**
leonina Illiger, 1806 *(Megilla) nomen nudum*
leonis Cockerell, 1933 An, E **(476)**
leopoldi Cockerell, see *felina* (Friese)
lepida Eversmann, see *ireos* (Pallas)
lepidodea Dours, 1869 Un (An), P **(450)**
leptocoma Lieftinck, see *malaccensis* Friese
lesquerellae (Cockerell), 1897 An (Po), N **(460, 462, 556)**
leucocephala Friese, see *annos* (Vachal)
leucomelaena Dalla Torre, 1896 Un (Po), P, n. name for *An. melaleuca* Walker, 1871, not Lepeletier, 1841 **(450)**
leucomelaena Illiger, see *albigena* (Lepeletier)
leucophaea Pérez, 1879 An, P **(464)**
leucophora Cockerell, see *grandiceps* Friese
leucopyga Friese, 1911 An, E **(476)**
leucorhina Cockerell, 1917 An, P **(460, 464)**
leucospila Cockerell, see *epichariformis* Gribodo
leucosticta Hedicke, 1940 Un (An), P **(450)**
leucostomella Cockerell, see *urbana* Cresson
liberica (Cockerell), 1930 Am (An), E **(515)**
librata Illiger, 1806 *(Megilla) nomen nudum*
libyphaenica Gribodo, 1893 An, P **(462)**
lieftincki Brooks n. sp. Am, O **(438, 512, 513, 550–552)**
lilacine Cockerell, see *cingulata* (Fabricius)
limassolica Mavromoustakis, An, P, original description not found **(464)**
*limbatus (*Saussure), 1890 *Pachymelus* (Ha) **n. comb.**, E
linsleyi Timberlake, 1941 An, N **(479, 481)**
liriope (Bingham), see *mucorea* (Klug)
lisalana Cockerell, see *cincta* (Fabricius)
lisbonensis Cockerell, see *plumipes* (Pallas)
litorana Priesner, see *quadrifasciata* (de Villers)
liturata Lepeletier, see *affinis* Brullé
livingstonei Cockerell, see *tetradonta* Cockerell
loczyi Morawitz, 1892 An, O **(496)**
loewi Fedtschenko, 1875 An, P **(492)**
lomamica (Cockerell), 1936 Am (An), E **(504)**
longipes Morawitz, 1884 An, P **(492)**
longmani (Rayment), 1947 Am (An), A **(511)**
longula (Rayment), 1947 Am (An), A **(511)**
loveridgei Cockerell, see *acraensis* (Fabricius)
lucknoviensis Radoszkowsky, see *subcoerulea* (Lepeletier)
luluana Cockerell, see *triangulifera* (Cockerell)
lumbwana Cockerell, 1946 An, E **(492)**
lusitanica Friese, see *affinis* Brullé
lusoria Cockerell, see *oldi* Meade-Waldo
luteola Rayment, see *chlorocyanea* (Cockerell)
luteodimidiata Dours, 1869 Un (An), T **(450)**
lutescens Walker, 1871 Un (An),P **(450)**
lutulenta (Klug), 1845 Am *(Saropoda),* P **(515)**
luzonica (Cockerell), 1914 Am (An), O **(513)**
maclachlani (Fedtschenko), 1875 Am (An), P (=*An. mervensis* Cockerell, 1933) **(508, 510)**
macrognatha Gerstaecker, 1871 *(Eucera)* =*Eucara* (Anthophoridae; Eucerini)
macroleuca (Cockerell), 1922 Am (An), O **(515)**
maculicornis (Lepeletier), 1841 Am (An), E (=*An. domingensis* Lepeletier, 1841) **(515)**
maculifrons Cresson, 1879 An, N **(496)**
maculigera Priesner, 1957 An, P **(474, 476)**
madecassa (Saussure), 1890 Am (An), E **(504)**
maderae Sichel, see *quadrifasciata* (de Villers)
magnilabris Fedtschenko, see *savignyi* (Lepeletier)
magrettii (Bingham), 1897 *Elaphropoda* (Ha), O (=*Ha. fletcheri* Cockerell, 1920)
maiella Lieftinck, see *tainanicola* (Strand)
malabarica Gmelin, 1790 *(Apis),* E, =*Nomia curvipes* (Fabricius) 1781 (Halictidae)
malaccensis (Friese), 1918 [as *villosula* ssp.] Am (*Antophora* [sic]), O (=*Am. leptocoma* Lieftinck, 1956 **n. syn.**) **(512, 513, 556)**
malelana Cockerell, see *circulata* (Fabricius)
malenominatus Schulz, see *festivus* (Dours)
mangkamensis Wu, 1982 An, P **(478)**
manni Mocsáry, see *quadricolor* (Erichson)
marginata Smith, 1854 An, NT (=*An. histrio* Dours, 1869; =*Po. cleomis* Cockerell, 1896; =*An. popenoei* Cockerell, 1949 **n. syn.**; =*An. peleni* Cockerell, 1949 **n. syn.**) **(479, 481)**
marqueti (Pérez), 1895 Am (An), P **(515)**
marsupoda Christ, 1791 Un *(Apis),* P **(450)**
martensi Fedtschenko, 1875 An, P **(475, 476)**
matopoensis Cockerell, 1933 An, E **(492)**
mauritanica (Benoist), 1950 [as *alternans* ssp.] Am (An), P **(505)**
mcnamarae Cockerell, see *custos* (Dalla Torre)
medicorum Cockerell, see *punctifrons* (Walker)
mediocinctus Cockerell, 1917 *Pachymelus,* E
mediorufa (Cockerell), 1920 Am (An), E **(504)**
mediozonata Laboulbene, 1870 Un (An), P **(450)**
mediterranea Alfken, see *quadrifasciata* (de Villers)
megarrhina Cockerell, 1910 An, O (=*An. soluta* Cockerell, 1910 [as *megarrhina* ssp.] **n. syn.**) **(438, 482–484)**
megasoma Cockerell, see *armata* Friese
melaleuca Walker, see *leucomelaena* (Dalla Torre)
melaleuca Lepeletier, 1841 Un (An), T **(450)**
melanocephala Morawitz, 1894 An, P **(466)**
melanocera (Cockerell), 1946 Am (An), E **(504)**
melanodonta (Cockerell), 1933 Am, E **(504)**
melanognatha Cockerell, 1911 An, O **(457, 459, 460)**
melanopoda Illiger, 1806 *(Megilla) nomen nudum*
melanops Cockerell, see *squammulosa* Dours
melanopyga Fedtschenko, 1875 An, P **(476)**
melanopyrrha Dours, 1869 Un (An), T, transferred to *Deltoptila* by LaBerge & Michener, 1963, but

placement tenuous **(450)**
meleagrus Gribodo, see *hova* (Saussure)
melfordi Cockerell, 1908 Un (An), N (fossil; impossible to determine if this specimen actual belongs to *Anthophora,* see Zeuner and Manning, 1976) **(523)**
meliturga Illiger, 1806 (An) *nomen nudum,* = *Chalicodoma pyrrhopeza* Gerstaecker, 1869, according to Gerstaecker, 1869
mellina Priesner, 1957 An, E **(492)**
meltonensis (Rayment), 1951 Am *(Asaropoda),* A **(515)**
mephistophelicana (Strand), 1911 Am (An), E **(515)**
mercetiana Vachal, see *holoxantha* Pérez
meridionalis Pérez, see *retusa* (Linnaeus)
meridionalis Fedtschenko, 1875 An, P **(476, 489)**
mervensis Cockerell, see *maclachlani* (Fedtschenko)
mervensis Radoszkowsky, see *quadrifasciata* (de Villers)
mesasiatica Popov, see *bimaculata* (Panzer)
mesopyrrha (Cockerell), 1930 Am (An), O **(438, 512, 513)**
metallica Fabricius, 1804 *(Megilla)* = *Augochloropsis* (Halictidae) (= *Megilla chloris* Fabricius, 1804)
metallica Morawitz, 1886 An, PO **(482)**
mewiella (Rayment), 1944 Am (An), A, publication date is not 1942 **(512)**
mexicana Dours, 1869 Un (An), T **(450)**
michaelis (Cockerell), 1930 Am (An), E **(502, 504)**
micheneri Brooks n. sp., An, E **(438, 492, 543, 544)**
micrelephas Smith, 1879 *Pachymelus,* E (= *Ha. cambouei* Saussure, 1890 **n. syn.**; *Pachymelus soror* Mocsáry, 1896)
microdonta Dufour *nomen nudum* by Dours, 1869
microleuca Cockerell, see *nivescens* (Cockerell)
mimadvena (Cockerell), 1916 Am (An), E (= *An. andersoni* Cockerell, 1933 **n. syn.**; = *An. cingulicauda* Cockerell, 1933 **n. syn.**; = *An. cuneata* Cockerell, 1933 **n. syn.**; = *An. nigromixta* Cockerell, 1936 **n. syn.**) **(438, 507, 508)**
mimetica Cockerell, 1927 Ha, O
mimica (Rayment), 1944 [as *adamsella* ssp.] Am (An), A, see Rayment's Text Figure IX, figs. 1, 2, 3a, 4c **(511)**
minuta Fabricius, 1793 = *Hylaeus* (Colletidae)
miserabilis (Cresson), 1878 Ha (An) **n. comb.**, N (= *Emphoropsia murina* Cockerell, 1909 [as *murihirta* ssp.] **n. syn.**)
mixta Lepeletier, see *quadrimaculata* (Panzer)
mlokosewitzi Radoszkowsky, see *plagiata* (Illiger)
moderna Morawitz, see *rutilans* Dours
modesta Smith, see *godofredi* (Dours) **(551)**
modestoides Brooks n. sp. Am, P **(438, 510, 548, 550)**
moelleri Bingham, see *nuda* (Radoszkowsky)
moesta Popov, 1952 Ha, P
monacha Erichson, see *retusa* (Linnaeus) **(462)**
mongolica Morawitz, 1890 An, P **(496)**
montana Cresson, 1869 An, N (= *An. smithii* Cresson, 1869 **n. syn.**; = *Po. cardui* Cockerell, 1897 **n. syn.**) **(438, 466, 468, 469, 556)**
montana Radoszkowsky, see *radoszkowskyi* (Dalla Torre)
montezumia Smith, see *badia* (Dours)
montislinguarum Schulz, see *furcata* (Panzer)
montivaga (Fedtschenko), 1875 Am (An), P **(510)**
moraguesii Friese, see *balearica* (Friese)
morawitzi Ponomareva, see *ponomarevae* Brooks
morawitzi Alfken & Blüthgen, see *biciliata* Lepeletier
moribunda (Illiger), see *albigena* (Lepeletier)
moricei (Friese), 1899 An (Po), P (= *An. nigripilis* Priesner, 1957 [as *moricei* ssp.] **n. syn.**) **(486)**
morrisoni (Cresson), 1878 *Ha* (An) **n. comb.**, N (= *Ha. pascoensis* Cockerell, 1898 [as *floridana* ssp.] **n. syn.**)
mortuaria Timberlake, 1937 An, N **(494, 496)**
mucida Cresson, see *cressonii* (Dalla Torre)
mucida Gribodo, see *biciliata* Lepeletier
mucorea (Klug), 1845 Am *(Megilla),* P (= *An. liriope* Bingham, 1898 **n. syn.**; = *An. delicata* Cockerell, 1911 **n. syn.**) **(508, 510)**
mucorea Illiger, 1806 *(Megilla) nomen nudum*
mucoriventris Friese, 1922 [as *harmalae* spp.] An, P **(476)**
murihirta (Cockerell), 1905 Ha *(Emphoropsis)* **n. comb.**, N
murina Cockerell, see *miserabilis* (Cresson)
murina Fedtschenko, 1875 An, P **(486)**
murrayensis (Rayment), 1939 Am (An), A (= *An. murrayensis* Rayment, 1935, *nomen nudum)* **(511)**
*murrayi (*Rayment), 1944 [as *luteola* ssp.] Am (An), A, publication date not 1942 **(512)**
murutica Friese, 1919 [as *fulvitarsis* ssp.] An, P **(466, 555, 556)**
muscaria Fedtschenko, 1875 An, P **(486, 489)**
nana Radoszkowsky, see *albigena* (Lepeletier)
nasuta Lepeletier, see *fulvitarsis* Brullé **(558)**
natalensis Friese, see *capensis* (Friese)
natensis Cockerell, see *pygmaea* Meade-Waldo
nativitatis (Cockerell), 1933 Am (An), E **(506)**
neavei Vachal, 1910 An, E **(496)**
nebracensis Swenk, see *urbana* Cresson
neglecta Timberlake & Cockerell, 1936 An, N **(464–466)**
neofurcata Sladen, see *terminalis* Cresson
neomexicana Cockerell, see *bomboides* Kirby
nicolai Cockerell, see *urbana* Cresson
nidulans Fabricius, 1793 *(Apis)* = *Bombus* (Apidae)
niger Friese, see *ocularis* Saussure
niger Friese, see *plumipes* (Pallas)
nigrescens Friese, see *plagiata* (Illiger)
nigriceps Morawitz, 1886 An, P **(460, 464)**
nigricornis (Morawitz), 1873 Am (An), P (= *An. picicornis* Fedtschenko, 1875) **(510)**
nigrifacies Friese, 1905 An, E **(460, 462, 464)**
nigrifrons Cockerell, 1931 An, O **(478)**
nigrilabris Spinola, 1838 An, P (= *An. nigrilabris* Spinola, 1838 male, p. 546, no. 22; = *An. cinereiceps* Alfken, 1926) **(462)**
nigrilabris Spinola, see *saropodoides* (Dalla Torre)
nigripes Friese, see *plumipes* (Pallas)
nigripes Morawitz, see *plagiata* (Illiger) **(489)**
nigripes Pérez, 1879 An, P (possible syn. of *An. fulvodimidiata* Dours) **(492)**
nigripilis Priesner, see *moricei* Friese
nigriplantis Illiger, 1806 *(Megilla) nomen nudum*
nigrita Fabricius, see *tricolor* (Fabricius)
nigritarsis (Friese), 1905 Am (An), E **(504)**
nigritarsis Dover, see *zonata* (Linnaeus)
nigrithorax Dalla Torre, see *albigena* (Lepeletier)
nigritula Cockerell, 1924 An, N **(494, 496)**

nigriventris Zetterstedt, 1838 (An) = *Osmia* (Megachilidae)
nigriventris Friese, see *acraensis* (Fabricius)
nigroaeruginosa Dours, 1869 Un (An), Unknown origin **(450)**
nigrociliata Pérez, 1895 An, P **(486)**
nigrocincta Lepeletier, see *subterranea* Germar
nigrocincta Provancher, see *flavocincta* Huard
nigrocinctula Dours, see *ventilabris* Lepeletier
nigroclypeata Friese, 1909 Am (An), E **(506)**
nigrofulva Lepeletier, see *plumipes* (Pallas)
nigromaculata Lucas, see *robusta* (Klug)
nigromixta Cockerell, see *mimadvena* (Cockerell)
nigropilosa (Friese), 1896 Am (Po), P **(515)**
nigropyga Strand, see *dufourii* Lepeletier
nigroscopacea Friese, see *pedata* Eversmann
nigrotarsa Wu, 1979 *Elaphropoda,* P
nigrovittata Dours, see *balneorum* Lepeletier
nitidula Dours, 1869 (An) = *Exomalopsis* (Anthophoridae; Exomalopsini) according to Timberlake, 1980
nivea (Lepeletier), 1841 Am (An), E **(515)**
niveata (Friese), 1905 Am (An), E (= *An. amphigynops Cockerell,* 1933 [as *niveata* ssp.] **n. syn.**) **(438, 508–510)**
niveiceps Friese, see *arequipensis* Brèthes
niveifacies Hedicke, 1940 An, P **(496)**
niveiventris Friese, 1919 [as *robusta* ssp.] An, P **(466)**
niveocincta (Smith), 1854 Am (An), P (= *An. bimaculifera* Walker, 1871; = *Po. bimaculosus* Dalla Torre, 1896, n. name for *bimaculifera* Walker female, no. 284; = *Po. flaviceps* Friese, 1899 [as *albigenus* ssp.] **n. syn.**) **(498, 502, 509–511)**
niveohirta Friese, see *dispar* Lepeletier
nivescens (Cockerell), 1936 Am (An), E (= *An. microleuca* Cockerell, 1937 **n. syn.**) **(510)**
nivosella Priesner, see *cana* (Walker)
nonconforma Brooks n. sp., Am, E **(438, 444, 496, 515, 552, 553, 556)**
norvegica Nylander, see *furcata* (Panzer)
nubana (Cockerell), 1946 Am (An), E **(504)**
nubica (Lepeletier), 1841 Am (An), EP (= *An. congoensis* Friese, 1909 [as *nubica* ssp.] **n. syn.**) **(506, 507)**
nubilipennis (Cockerell), 1930 *Habrophorula* (Ha), O
nubiterrae Viereck, see *terminalis* Cresson
nuda (Radoszkowsky), 1882 *Elaphropoda* (An) **n. comb.,** O, (= *Ha. moelleri* Bingham, 1897 **n. syn.**)
nudata Provancher, see *terminalis* Cresson
nurrana Cockerell, 1931 An, E **(496)**
obesa Giraud, see *balneorum* Lepeletier **(557)**
obscurella Alfken, see *furcata* (Panzer)
obscuriceps (Friese), 1905 [as *circulata* ssp.] Am (An), E (= *An. grisella* Cockerell, 1932 **n. syn.**) **(504)**
obscurus Friese, see *hova* (Saussure)
obscurus Friese, see *retusa* (Linnaeus)
obsoleta (Illiger), 1806 (An) *nomen nudum*
obtusispina Wu, 1982 An, P **(478)**
occidentalis Cresson, 1869 An, N **(450, 478)**
occipite Morawitz, see *pedata* Eversmann
occulta Hedicke, 1938 An, P **(496)**
ochroleuca (Pérez), 1879 Am (An), P **(504, 505)**
octomaculatus Friese, see *ocularis* (Saussure)
ocularis (Saussure), 1890 *Pachymelus* (Ha) **n. comb.,** E (= *Pachymelus niger* Friese, 1922 **n. syn.**; = *Pachymelus octomaculatus* Friese, 1922 [as 8-*maculatus*] **n. syn.**; = *Pachymelus ciliatus* Friese, 1922 **n. syn.**; = *Pachymelus flavithorax* Benoist, 1962 **n. syn.**)
odontura Cockerell, see *africana* (Friese)
ogilviei (Cockerell), 1932 Am (An), E **(504)**
oldi Meade-Waldo, 1914 An, E (= *An. lusoria* Cockerell, 1921 [as *oldi* ssp.] **n. syn.**; = *An. albopictula* Cockerell, 1933 **n. syn.**) **(492)**
olgae Fedtschenko, 1875 An, P **(474–476)**
omeiensis Wu, 1979 Ha, O
omissa (Priesner), 1957 Am (An), P **(504)**
onosmarum Morawitz, 1876 An, P **(474, 476)**
optima Cockerell, see *armata* Friese
oraniensis (Lepeletier), 1841 Ha (An), P
orbifrons Lieftinck, 1974 Ha, O
orientalis Morawitz, 1878 An, P (= *Po. flaviventris* Friese, 1896 [as *orientalis* ssp.]) **(462, 464, 489)**
ornata Gistel, 1857 Un (An), P **(450)**
orophila Cockerell, 1910 An, P (= *An. pseudorophila* Wu, 1982 **n. syn.**) **(484)**
orotavae (Saunders), 1904 An (Po), P **(484, 486)**
oschanini Fedtschenko, see *freimuthi* Fedtschenko
oxygona Dours, see *robusta* (Klug) **(556, 557)**
pachyodonta Cockerell, 1923 An, N **(494, 496)**
pachypoda Cockerell, see *quadrimaculata* (Panzer)
pacifica Cresson, 1878 An, N (= *An. carbonaria* Cresson, 1879 [dark form]; = *An. ignava* Cresson, 1879; = *Po. infernalis* Dalla Torre 1896 [n. name for *carbonaria* Cresson, 1879, not Morawitz, 1876] **n. syn.**; = *An. corvicolor* Cockerell, 1905 **n. syn.** [dark form]; = *An. subignava* Cockerell, 1929 **n. syn.**; = *An. pernicis* Timberlake, 1951 **n. syn.**) **(450, 466)**
padiola Vachal, 1909 Un (An), E **(450)**
pagdeni Lieftinck, 1956 Am, O **(513)**
pahangensis Cockerell, see *pendleburyi* (Cockerell)
pahangensis Meade-Waldo, see *himalajensis* (Radoszkowsky)
palestinensis Hedicke, see *plumipes* (Pallas)
pallescens Morawitz, 1895 Un (An), P **(450)**
pallida (Timberlake), 1937 Ha *(Emphoropsis)* **n. comb.,** N
pallidicinctus Cameron, see *vestita* Smith
palmipes Rossi, see *plumipes* (Pallas)
pamirica Hedicke, see *robusta* (Klug)
pamiricola Hedicke, see *plagiata* (Illiger)
paradoxa Brooks n. sp., Am, E **(438, 506, 516, 552–554, 556)**
paranensis Holmberg, 1903 An, T (= *An. paranensis* Holmberg, 1887, *nomen nudum;* = *An. saltensis* Holmberg, 1903 **n. syn.**; = *An. hirpex* Vachal, 1904) **(466, 468)**
parapulchra (Rayment), 1947 Am (An), A **(511)**
parhypate Lieftinck, 1975 Am, O **(511)**
parietina Fabricius, see *plagiata* (Illiger) **(478, 489)**
pascoensis Cockerell, see *morrisoni* (Cresson)
passerini Sichel, see *tarsata* (Spinola)
patruelis Cockerell, 1931 An, O **(460)**
pauperata Walker, 1871 Un (An), P **(450)**
pedata Eversmann, 1852 An, P (= *An. occipite* Morawitz, 1878 [as *pedata* ssp.] **n. syn.**; = *An.*

nigroscopacea Friese, 1919 [as *pedata* ssp.] **n. syn.**) **(462)**
pekinensis Cockerell, 1911 Ha, O (=*Ha. alashanica* Gussakovsky, 1935)
peleni Cockerell, see *marginata* Smith
pelmata Lieftinck, 1974 Ha, O
pendleburyi (Cockerell), 1929 Am (An), O, n. name for *An. pahangensis* Cockerell, 1927 [as *insularis* ssp.], not Meade-Waldo, 1914 (=*An. anthreptes* Lieftinck, 1944) **(513)**
penicillata Friese, 1905 (An) =*Eucara* (Anthophoridae; Eucerini)
pennata Lepeletier, see *plumipes* (Pallas)
pennipes Forster, see *retusa* (Linnaeus)
perasserta (Rayment), 1947 Am (An), A (=*An. assertiella* Rayment, 1947 [as *perasserta* ssp.] **n. syn.**) **(511)**
percarinata (Cockerell), 1930 *Elaphropoda* (Ha), O
perdita Cockerell, 1946 An, E **(492)**
perezi Morawitz, 1895 An, P **(476)**
peringueyi (Friese), 1911 *Pachymelus* (An) **n. comb.**, E
peritomae Cockerell, 1905 [as *curta* ssp.] An, N (=*An. interspersa* Cockerell, 1907 [as *peritomae* ssp.]; =*An. tinctula* Cockerell, 1907 [as *peritomae* ssp.]) **(494, 496)**
perlustrata Priesner, 1957 An, P **(492)**
pernicis Timberlake, see *pacifica* Cresson
pernigra Cresson, see *terminalis* Cresson **(489)**
perplexa Radoszkowsky, see *crassipes* Lepeletier
perpulchra (Rayment), 1947 Am (An), A (=*An. wallaciella* Rayment, 1947 [as *perpulchra* ssp.] **n. syn.**) **(511)**
persica Radoszkowsky, see *sichelii* Radoszkowsky
persicorum Cockerell, see *farinosa* (Klug)
personata Illiger, see *fulvitarsis* Brullé **(460)**
petersenii Morawitz, 1884 An, P **(496)**
petrophila Cockerell, 1905 [as *curta* ssp.] An, N **(494, 496)**
pexata LaBerge & Michener, 1963 *Deltoptila*, T
phenax (Cockerell), 1898 An (Po), N **(494, 496)**
phaceliae Brooks n. sp. An, N **(438, 449, 479, 481, 537–540)**
picicornis Fedtschenko, see *nigricornis* (Morawitz)
pilifrons Packard, 1869 An, T (=*An. guachalae* Cameron, 1903; =*An. atripes* Friese, 1925) **(468)**
piligera Friese, 1905 (An) =*Eucara* (Anthophoridae; Eucerini)
pilipes Fabricius, see *plumipes* (Pallas) **(440, 457, 458)**
pilosa Lespes, 1858 Un (An), P **(450)**
pilosa Morawitz, see *prshewalskii* Morawitz
pilosella Friese, see *plagiata* (Illiger)
pingshiangensis Strand, see *plumipes* (Pallas)
pipiens Mocsáry, see salviae (Morawitz) **(460, 504)**
plagiata (Illiger), 1806 An *(Megilla)*, P (=*Apis parietina* Fabricius, 1793, not Fourcroy, 1785; =*An. villosa* Herrich-Schaeffer, 1840 **n. syn.**; =*An. fulvocinerea* Dours, 1869 [as *parietina* ssp.] **n. syn.**; =*An. turanica* Fedtschenko, 1875 **n. syn.**; =*An. schenkii* Dalla Torre, 1877 [as *parietina* ssp.] **n. syn.**; =*An. simplicipes* Morawitz, 1880 **n. syn.**; =*An. mlokosewitzi* Radoszkowsky, 1884 **n. syn.**; =*An. nigripes* Morawitz, 1886 **n. syn.**; =*An. simplex* Morawitz, 1894 **n. syn.** [n. name for *An. simplicipes* Morawitz, 1894, not Morawitz, 1880]; =*Po. semiater* Friese, 1896 [as *simplicipes* ssp.] **n. syn.**; =*Po. nigrescens* Friese, 1897 [as *parietinus* ssp.] **n. syn.**; =*An. pulcherrima* Bingham, 1897 **n. syn.**; =*An. filchnerae* Friese, 1908 **n. syn.**; =*An. khambana* Cockerell, 1910 **n. syn.**; =*An. atramentata* Cockerell, 1911 [as *khambana* ssp.] **n. syn.**; =*An. pilosella* Friese, 1919 **n. syn.**; =*An. smirnovi* Kuznetzov-Ugamsky, 1927 **n. syn.**; =*An. pamiricola* Hedicke, 1931 [as *parietina* ssp.] **n. syn.**; =*An. chodjana* Hedicke, 1938 [as *khambana* ssp.] **n. syn.**; =*An. ladakhana* Hedicke, 1940 [as *parietina* ssp.] **n. syn.**; =*An. baltistanica* Hedicke, 1940 [as *parietina* ssp.] **n. syn.**; =*An. himalayaensis* Wu, 1982 [as *pulcherrima* ssp.] **n. syn.**) **(477, 478, 489)**
plagioleuca Hedicke, 1940 Un, P **(450)**
planca Pérez, 1895 An, P **(476)**
plantifera Lieftinck, 1974 Ha, O
platti Timberlake, 1951 An, N **(460, 462)**
plebeja Morawitz, 1894 Un (An), P **(450)**
plumigera Gribodo, 1893 (An) =*Centris muralis* Burmeister, 1876 (Anthophoridae; Centridini)
plumipes Fabricius, see *atrocincta* (Lepeletier)
plumipes (Pallas), 1772 An *(Apis)*, P (=*Apis pilipes* Fabricius, 1775; =*Andrena hirsuta* Fabricius, 1787; =*Apis rufipes* Christ, 1791; =*Apis palmipes* Rossi, 1792; =*An. nigrofulva* Lepeletier, 1841 **n. syn.**; =*An. pennata* Lepeletier, 1841 **n. syn.**; =*An. sicula* Smith, 1854 [female only] **n. syn.**; =*An. villosula* Smith, 1854; =*An. squalens* Dours, 1869 [as *acervorum* ssp.] **n. syn.**; =*Po. albipes* Friese, 1896 [as *acervorum* ssp.] **n. syn.**; =*Po. niger* Friese, 1896 [as *acervorum* ssp.] **n. syn.**; =*Po. nigripes* Friese, 1896 [as *acervorum* ssp.] **n. syn.**; =*An. soror* Pérez, 1905, and described as new again in 1910; =*An. dimidiata* Alfken, 1913 [as *acervorum* ssp.] **n. syn.**; =*An. intermixta* Alfken, 1913 [as *acervorum* ssp.] **n. syn.**; =*An. pingshiangensis* Strand, 1913 **n. syn.**; =*An. varians* Friese, 1922 [as *acervorum* ssp.] **n. syn.**; =*An. lisbonensis* Cockerell, 1922 [as *acervorum* ssp.] **n. syn.**; =*An. palestinensis* Hedicke, 1936 [as *acervorum* ssp.] **n. syn.**; =*An. cypriaca* Mavromoustakis, 1957 [as *acervorum* ssp.] **n. syn.**) **(440, 447–451, 453, 457–460)**
pluto Dours, 1869 Un (An), T, transferred to *Deltoptila* by LaBerge & Michener, 1963, but placement tenuous **(450)**
podagra Lepeletier, 1841 An, P (=*Megilla dentipes* Illiger, 1806 *nomen nudum;* =*An. rufa* Lepeletier, 1841 **n. syn.**; =*An. segnis* Eversmann, 1852; =*An. cinerea* Eversmann, 1852 **n. syn.**; =*An. tomentosa* Mocsáry, 1878; =*An. taurica* Friese, 1922 **n. syn.**) **(476)**
politifrons Cockerell, see *punctifrons* (Walker)
ponomarevae Brooks, An, P, n. name for *An. morawitzi* Ponomareva, 1966, Entomol. Oboz. 45:162-164 (translated into English in Entomol. Review 45:90-91), not Alfken & Blüthgen, 1937 **(476)**
popenoei Cockerell, see *marginata* Smith
porterae Cockerell, 1900 An, N (=*An. semiflava* Cockerell, 1905 [as *porterae* ssp.]; =*An. watsoni* Cockerell, 1911 [as *porterae* ssp.]; =*An. thalassiana* Cockerell, 1920 [as *porterae* ssp.]; = *An. chlorops*

Michener, 1936 **n. syn.**; =*An. utahensis* Michener, 1936 [as *chlorops* ssp.] **n. syn.**) **(438, 463–466)**
postica Vachal, 1910 An, E **(496)**
potanini (Morawitz), 1890 Am (An), P **(515)**
praecox Friese, 1909 [as *krebsi* ssp.] An, E (=*An. praecox* Friese, 1911 [as *wartmanni* ssp.]; Friese (1911) said he originally intended to describe *praecox* as ssp. of *wartmanni* and not *krebsi;* =*An. aliceae* Cockerell, 1932 **n. syn.**) **(489, 492)**
preissi (Cockerell), 1910 Am (An), A (=*An. froggatti* Cockerell, 1914 [as *preissi* ssp.] **n. syn.**) **(515)**
pretiosa Friese, 1919 [as *fulvitarsis* ssp.] An, P **(466)**
priesneri Alfken, 1932 An, P **(486)**
proboscidea Lieftinck, 1956 Am, O **(513)**
procera Costa, see *subterranea* Germar
proserpina Gribodo, see *himalajensis* (Radoszkowsky)
proxima Morawitz, 1894 An, P **(496)**
prshewalskii Morawitz, 1880 An, O (=*An. pilosa* Morawitz, 1880) **(470, 474, 476)**
pruinosa Smith, 1854 An, P (=*An. stefanii* Pérez, 1902 **n. syn.**) **(464)**
pseudobasalis Strand, see *armata* Friese
pseudobomboides (Meade-Waldo), 1914 Am (An), O (=*Am. bombiomorpha* Wu, 1983 **n. syn.**) **(512, 513)**
pseudococcina Meade-Waldo, see *africana* (Friese)
pseudorophila Wu, see *orophila* Cockerell
pseudosicula Hedicke, see *quadricolor* (Erichson) **(556)**
pubescens (Fabricius), 1781 An *(Apis),* P (=*Apis grisea* Christ, 1791; =*An. flabellifera* Lepeletier, 1841; =*An. labronigro* Lebedev, 1932 [as *pubescens* ssp.] *nomen nudum;* =*An. flabellipes* Lichenstein, 1871) **(470, 489)**
pulcherrima Bingham, see *plagiata* (Illiger)
pulcherrima Wu, 1985 *Elaphropoda,* O
pulchra (Smith), 1854 Am (An), A (=*An. townleyella* Rayment, 1947 [as *pulchra* ssp.] **n. syn.**) In the British Museum the female type of *An. pulchra* Smith, B. M. Type Hym. 17B666a, is not the type according to D. Baker. The type was apparently repinned and lost and the specimen in its place is *Am. niveocincta* (Smith) **(511).**
pulsella Dours, 1869 Un (An), T **(450)**
pulverea (Walker), 1871 Am (An), P, see note under *salviae* (Morawitz) **(515)**
pulverosa Smith, 1854 An, P (=*An. byssinoides* Benoist, 1950 **n. syn.**) **(492)**
punctata (Rayment), 1931 Am *(Asaropoda),* A **(515)**
punctifrons (Walker), 1871 Am (An), P (=*An. medicorum* Cockerell, 1910 **n. syn.**; =*An. politifrons* Cockerell, 1946 **n. syn.**) **(504)**
punctilabris Pérez, 1879 An, P **(464)**
puttalama (Strand), 1913 [as *zonata* ssp.] Am (An), O **(510, 511)**
pygmaea Gussakovsky, see *gussakovskyi* (Popov)
pygmaea Dours, 1869 Un (An), T **(450)**
pygmaea Meade-Waldo, 1914 An, E (=*An. torridella* Meade-Waldo, 1914 **n. syn.**; =*An. natensis* Cockerell, 1935 **n. syn.**) **(492)**
pyralitarsis Dours, see *ursina* Cressson
pyramidalis Kirby, see *albigena* (Lepeletier)
pyropyga Dours, 1869 Un (An), E **(450)**
pyrozonata Dours, 1869 Un (An), T **(450)**
quadrata (Cockerell), 1911 [as *albigena* ssp.] Am (An), O (=*An. cyaneotincta* Cockerell, 1920 **n. syn.**) **(497, 502, 504, 509)**
quadricincta Fabricius, 1798 *(Apis)* =*Halictus* (Halictidae)
quadricincta Eversmann, see *eversmannii* (Dalla Torre & Friese)
quadricolor (Erichson), 1840 An *(Megilla),* P (=*An. atrifrons* Smith, 1854 **n. syn.**; =*An. rectangula* Costa, 1863; =*An. smithii* Dours, 1869 **n. syn.**; =*An. dorsimacula* Dufour, *nomen nudum* by Dours, 1869; =*An. manni* Mocsáry, 1883; =*Megilla gallica* Dalla Torre & Friese, 1895 [n. name for *An. smithii* Dours, 1869, not Cresson, 1869] **n. syn.**; =*An. pseudosicula* Hedicke, 1929 [n. name for *sicula* Smith, 1854, male only] **n. syn.**) **(476)**
quadrifasciata (de Villers), 1789 Am *(Apis),* P (=*Megilla scalaris* Illiger, 1806, *nomen nudum,* **n. syn.**; =*Megilla fuliginosa* Illiger, 1806, *nomen nudum,* **n. syn.** [red form]; =*An. maderae* Sichel, 1867 [red form]; =*An. albescens* Dours, 1869 **n. syn.**; =*An. mervensis* Radoszkowsky, 1893; =*An. farinosa* Alfken, 1926 **n. syn.**; =*An. mediterranea* Alfken, 1927 **n. syn.** [red form]; =*An. teneriffensis* Cockerell, 1930 [as *quadrifasciata* ssp.] **n. syn.** [dark form]; =*An. litorana* Priesner, 1957 **n. syn.**; =*An. klugi* Priesner, 1957 [n. name for *An. farinosa* Alfken, 1926, not Klug, 1845] **n. syn.**) **(449–453, 456, 503–505)**
quadrimaculata (Panzer), 1798 An *(Apis),* P (=*Apis vulpina* Panzer, 1798, not Christ, 1791; =*Apis subglobosa* Kirby, 1802; =*An. mixta* Lepeletier, 1841 **n. syn.**; =*An. vara* Lepeletier, 1841 **n. syn.**; =*An. segusina* Gribodo, 1873 **n. syn.**; =*An. pachypoda* Cockerell, 1924 [as *vulpina* ssp.] **n. syn.**; =*An. alticola* Hedicke, 1931 [as *vulpina* ssp.] **n. syn.**) **(438, 485, 486)**
quadristrigata Dours, see *crassipes* Lepeletier
quinquefasciata Provancher, see *californica* Cresson
raddei Morawitz, 1876 An, P **(476, 489)**
radoszkowskii (Dalla Torre), 1896 Ha (Po), O, n. name for *Ha. montana* Radoszkowsky, 1882, not *An. montana* Cresson, 1869
radoszkowskyi Fedtschenko, 1875 An, P **(466, 486)**
radovae (Saussure), 1890 *Pachymelus* (Ha) **n. comb.**, E
rapida (Smith), 1879 Am (An), E **(515)**
raui Rohwer, see *bomboides* Kirby
rectangula Costa, see *quadricolor* (Erichson)
regalis (Cockerell), 1946 Am (An), E **(506)**
reichardti Stadelmann, 1898 *Pachymelus,* E (=*An. determinata* Friese, 1905 **n. syn.**)
reinigi Hedicke, see *latigena* Morawitz
repleta Dours, 1869 Un (An), P **(450)**
retusa (Linnaeus), 1758 An *(Apis),* P (=*Apis pennipes* Forster, 1770, *nomen nudum;* =*Apis aestivalis* Panzer, 1801; =*Apis haworthana* Kirby, 1802; =*An. intermedia* Lepeletier, 1841; =*Megilla monacha* Erichson, 1849 **n. syn.**; =*An. ruthenica* Morawitz, 1871 **n. syn.**; =*An. meridionalis* Pérez, 1879 [as *retusa* ssp.] **n. syn.**; =*Po. obscurus* Friese, 1896 [as *retusus* ssp.]; =*Po. sareptanus* Friese, 1896 [as *retusus* ssp.]; =*An. retusiformis* Cockerell, 1911 **n. syn.**; =*An. fasciata* Alfken, 1913 [as *retusa* ssp.] **n. syn.**; =*An. baicalensis* Hedicke, 1929 [as *aestivalis* ssp.] **n. syn.**;

=*An. seminigra* Benoist, 1930 [as *retusa* ssp.] **n. syn.**; =*An. alaica* Hedicke, 1931 [as *aestivalis* ssp.] **n. syn.**; =*An. tschelcarica* Ponomareva, 1967 [as *monacha* ssp.] **n. syn.)** **(438, 440, 460–462)**
retusiformis Cockerell, see *retusa* (Linnaeus)
rhodesiae Meade-Waldo, 1914 An, E **(492)**
rhodoscymna (Cockerell), 1905 Am (An), A **(515)**
rhodothorax Michener, 1936 An, N (=*An. emarginata* Timberlake, 1937) **(496)**
richaensis Alfken, 1938 [as *bimaculata* ssp.] An, P **(492)**
rickae (Rayment), 1951 Am *(Asaropoda),* A **(515)**
rivolleti Pérez, 1895 An, P (=*An. ambigua* Pérez, 1895 **n. syn.**; =*An. guigliae* Dusmet, 1929 **n. syn.**) **(438, 484–486, 489)**
robbi Cockerell, 1911 An, O **(496)**
robinae Brooks n. sp. Am, E **(438, 506, 547–549)**
robusta (Klug), 1845 An *(Megilla),* P (=*Megilla caliginosa* Klug, 1845; =*An. nigromaculata* Lucas, 1846; =*An. oxygona* Dours, 1869 **n. syn.**; =*An. atroferruginea* Dours, 1869; =*An. atra* Friese, 1919 [as *robusta* ssp.] **n. syn.**; =*An. atratula* Friese, 1919 [as *robusta* ssp.] **n. syn.**; =*An. atroscopacea* Friese, 1919 [as *robusta* ssp.] **n. syn.**; =*An. pamirica* Hedicke, 1931 [as *fuliginosa* ssp.] **n. syn.**; =*An. atra* Hedicke, 1931 [as *fuliginosa* ssp.] **n. syn.**) **(464–466, 557)**
rogenhoferi Morawitz, 1872 An, P **(460, 461, 464)**
romandii Lepeletier, 1841 An, P (=*An. kuznetzovi* Cockerell, 1930 [as *romandii* ssp.] **n. syn.**) **(462, 478, 556)**
rothneyi Cameron, see *subcoerulea* (Lepeletier)
rotundata Panzer, see *bimaculata* (Panzer)
rowlandi (Meade-Waldo), 1914 Ha (An), O
rubricans (Cockerell), 1932 Am (An), E (=*An. aspilostoma* Cockerell, 1936 [as *rubricans* ssp.] **n. syn.**) **(504)**
rubricata (Rayment), 1951 Am *(Asaropoda),* A (=*Asaropoda dentata* Rayment, 1951 [as *rubricata* ssp.] **n. syn.**) **(515)**
rubricus Dours, 1869 An, P **(464)**
rufa (Rayment), 1931 Am *(Asaropoda),* A **(515)**
rufa Lepeletier, see *podagra* Lepeletier
rufescens (Friese), 1911 Am (An), A **(515)**
ruficaudis (Cameron), 1905 An *(Podalarius* [sic]), E (=*An. herbsti* Friese, 1911 **n. syn.**) **(462)**
ruficornis (Dours), 1869 Am (An), O **(515)**
ruficornis Fedtschenko, see *camelorum* (Cockerell)
rufipes (Lepeletier), 1841 Am (An), E **(515)**
rufipes Christ, see *plumipes* (Pallas)
rufipes Wu, 1983 Ha, P
rufiventris Friese, see *inclyta* Walker
rufolanata Dours, 1869 An, E (=*An. drewsenii* Sichel, *nomen nudum* by Dours, 1869, and Radoszkowsky, 1876; =*An. krebsi* Friese, 1905 **n. syn.**; =*An. armatilabris* Friese, 1911 **n. syn.**; =*An. chromatica* Cockerell, 1932 **n. syn.**; =*An. honorata* Cockerell, 1938 **n. syn.**) **(492, 557)**
rufovestita Cockerell, 1946 An, E (=*An. spinicauda* Cockerell, 1946 **n. syn.**) **(491, 492)**
rufozonata Dours, 1869 Un (An), T **(450)**
rugosa Radoszkowsky, 1884 An, P **(486)**
rugosissima Cockerell, see *tristissima* (Cockerell)
ruthenica Morawitz, see *retusa* (Linnaeus)
rutilans Dours, 1869 An, P (=*An. moderna* Morawitz, 1878) **(464, 466)**
rypara Dours, see *hispanica* (Fabricius)
sagemehli Morawitz, 1883 An, P **(476)**
salazariae Timberlake, 1937 An, N **(494, 496)**
saltensis Holmberg, see *paranensis* Holmberg
salteri (Cockerell), 1905 Am (An), A **(511)**
salviae (Morawitz), 1876 Am (An), P (=*An. pipiens* Mocsáry, 1879; the type labelled *An. pulverea* Walker, 1871, BMNH No. 17B605 is not the true type of *pulverea* Walker, but is conspecific with *pipiens*) **(460, 504)**
salviae (Michener), 1936 Ha *(Emphoropsis)* **n. comb.**, N
salviae (Panzer), 1804 An *(Lasius)* **n. comb.**, P (=*A. ephippium* Lepeletier, 1841 **n. syn.**; =*An. crinipes* Smith, 1854 **n. syn.**) **(457, 458, 460)**
salviarum Cockerell, 1897 Ha, N
samarensis (Cockerell), 1925 [as *whiteheadi* ssp.] Am (An), O **(510, 511)**
sapiens (Cockerell), 1911 Am (An), A **(511)**
sareptanus Friese, see *retusa* (Linnaeus)
saropoda Lamarck, see *bimaculata* (Panzer)
saropodoides (Dalla Torre), 1896 An (Po), P, n. name for *An. nigrilabris* Spinola, 1838, p. 543, no. 81, female, not p. 546, no. 22, male **(492)**
saussurei Fedtschenko, see *dubia* Eversmann
sauteri Friese, 1910 Un (An), O **(450)**
savignyi (Lepeletier), 1841 Am (An), P (=*An. magnilabris* Fedtschenko, 1875 **n. syn.**) **(504)**
scalaris Illiger, see *quadrifasciata* (de Villers)
schenckii Dalla Torre, see *plagiata* (Illiger)
schmiedeknechti Friese, see *byssina* (Klug)
schultzei Friese, 1909 An, E **(462)**
scopipes Spinola, 1838 An, P **(460, 462)**
scutellaris Swenk, see *bomboides* Kirby
scymna (Gribodo), 1893 Am (An), A (=*An. flava* Friese, 1911 **n. syn.**) **(515)**
sefrensis Cockerell, 1933 An, E **(496)**
segnis Eversmann, see *podagra* Lepeletier
segusina Gribodo, see *quadrimaculata* (Panzer)
selecta Priesner, 1957 An, P **(492)**
semenovi Kuznetzov-Ugamsky, 1927 Un (An), P **(450)**
semiater Friese, see *plagiata* (Illiger)
semicinerea Dours, 1869 Un (An), P **(450)**
semiflava Cockerell, see *porterae* Cockerell
semifulva (Cockerell), 1905 Ha *(Emphoropsis)* **n. comb.**, N
semigrisea Cockerell, see *grandiceps* (Friese)
seminigra Benoist, see *retusa* (Linnaeus)
seminuda Fabricius, 1781 Un *(Apis),* P **(450)**
semipulverosa (Dours), 1869 [as *quadrifasciata* ssp.] Am (An), PE **(515)**
semirufa (Friese), 1898 An (Po), P (=*An. fulviscopa* Alfken, 1930 **n. syn.**) **(473, 475, 476)**
semperi Fedtschenko, see *dubia* Eversmann
senahai Yasumatsu, see *dulcifera* (Cockerell)
senegalensis (Friese), 1922 Am (An), E **(515)**
senescens Lepeletier, 1841 An, P (=*An. ioidea* Dours, 1869 [as *senescens* ssp.]) **(460)**
senex Smith, 1878 Un (An), O **(450)**
senicula Pérez, 1902 An, P **(462)**
senilis Illiger, 1806 Un *(Megilla),* P **(450)**

senilis Eversmann, 1846 An, P (=*An. vetula* Eversmann, 1852; =*An. eversmanni* Radoszkowsky, 1869) **(462)**
senilis Walker, see *aegyptiaca* (Dalla Torre & Friese)
sergia (Nurse), 1904 An (Po), O **(464)**
sesquicincta (Erichson & Klug), 1842 Am *(Megilla),* O (=*Apis bicincta* Fabricius, 1793, not Schrank, 1781; =*An. indica* Radoszkowsky, 1882 **n. syn.**) **(438, 499, 503, 505, 557)**
shafferyella (Rayment), 1947 Am (An), A **(511)**
shagrensis Priesner, 1957 An, P **(492)**
shestakovi Gussakovsky, 1935 An, P **(496)**
sibiricus Gussakovsky, see *terminalis* Cresson
sichelii Radoszkowsky, 1868 An, P (=*An. persica* Radoszkowsky, 1876; =*An. dimidiozonata* Dours, 1869; =*Po. connexus* Nurse, 1904 **n. syn.**) **(460, 464)**
sichuanensis (Wu), 1987 An *(Anthomegilla),* O **(484)**
sichuanensis Wu, 1987 Ha, O
sicula Smith, see *plumipes* (Pallas) **(556)**
siewersi Morawitz, 1876 An, P **(486, 489)**
signata Brooks n. sp. An, N **(438, 448, 478, 479, 481, 489, 519, 535–539)**
simbana (Cockerell), 1936 Am (An), E **(515)**
simia Dours, 1869 Un (An), origin unknown **(450)**
similis Fedtschenko, 1875 An, P **(486)**
simillima Cresson, see *ursina* Cresson
simplex Morawitz, see *plagiata* (Illiger)
simplicipes Morawitz, see *plagiata* (Illiger)
sinensis Alfken, 1937 Ha, O
sinensis Wu, see *wuae* Brooks
sinensis (Wu), 1982 An *Clisodon,* P **(489)**
sinuatitarsis Friese, see *vestita* Smith
sjoestedti (Friese), 1909 Am (An), E (=*An. sjostedti* Friese, 1909) **(515)**
smirnovi Kuznetzov-Ugamsky, see *plagiata* (Illiger)
smithii Cresson, see *montana* Cresson
smithii Dours, see *quadricolor* (Erichson)
socia (Klug), 1845 Am *(Megilla),* P **(505)**
sodalis Cresson, see *bomboides* Kirby
soikai Benoist, 1961 An, E **(492)**
solitaria Radoszkowsky, see *femorata* (Olivier)
solitaria Ritsema, see *bomboides* Kirby
solskyi Fedtschenko, 1875 An, P **(476)**
somalica (Magretti), 1898 Am (Po), E (=*An. unicincta* Friese, 1922 **n. syn.**) **(502, 505)**
sordida (Rayment), 1931 Am (An), A **(515)**
sordidula (Rayment), 1931 Am (An), A **(515)**
soror Mocsáry, see *micrelephas* Smith
soror Pérez, see *plumipes* (Pallas)
soror Pérez, see *imitatrix* Cockerell
speciosa Friese, see *dispar* Lepeletier **(465)**
sperryi Cockerell, see *terminalis* Cresson
spilostoma (Cameron), 1905 Am (*Podalarius* [sic]), E **(504)**
spinicauda Cockerell, see *rufovestita* Cockerell
spinacoxa Brooks n. sp., An, P **(438, 470, 540, 541)**
spinipes (Friese), 1899 An (Po), P **(476)**
spinitarsis Wu, 1982 An, P **(484)**
spinolana Priesner, 1957 An, P **(460, 462)**
spodia Dours, 1869 Un (An), T **(450)**
sponsa Smith, see *abrupta* Say
squalens Dours, see *plumipes* (Pallas)
squalida Lepeletier, see *bimaculata* (Panzer)
squammulosa Dours, 1869 An, NT (=*An. curta* Provancher, 1895 **n. syn.**; =*An. melanops* Cockerell, 1926 [as *curta* ssp.] **n. syn.**; =*An. ensenadensis* Cockerell, 1941 [as *curta* ssp.] **n. syn.**) **(489, 490, 494, 496)**
stanfordiana Cockerell, see *bomboides* Kirby
stantoni (Cockerell), 1911 [as *zonata* ssp.] Am (An), O **(511)**
stefanii Pérez, see *pruinosa* Smith
strauchi Fedtschenko, 1875 An, P **(462)**
stschurovskyi Fedtschenko, see *cinerascens* Lepeletier
subaequa (Kohl), 1905 An (Po), P **(496)**
subcarinata Benoist, see *balneorum* Lepeletier
subcoerulea (Lepeletier), 1841 Am (An), O (=*An. lucknoviensis* Radoszkowsky, 1882 **n. syn.**; =*An. rothneyi* Cameron, 1897 **n. syn.**; =*An. amolita* Cockerell, 1911 **n. syn.**) **(502, 504)**
subflavescens Yasumatsu, see *dulcifera* (Cockerell)
subglobosa Kirby, see *quadrimaculata* (Panzer)
subglobulosa Provancher, see *terminalis* Cresson
subignava Cockerell, see *pacifica* Cresson
subinsularis Strand [as *insularis* ssp.] Am (An), listed by Cockerell, 1919, but original description not found **(497, 513)**
submicans Gussakovsky, 1935 An, P **(496)**
subrussata (Cockerell), 1925 Am (An), E **(513)**
subsalteri (Rayment), 1947 Am (An), A **(511)**
subserricornis Morawitz, 1894 An, P **(496)**
subtarsata Cockerell, see *californica* Cresson
subterranea Germar, 1826 An, P (=*Megilla chrysopoda* Illiger, 1806 **n. syn.**, *nomen nudum;* =*Megilla decrepita* Illiger, 1806 **n. syn.**, *nomen nudum;* =*An. nigrocincta* Lepeletier, 1841 **n. syn.**; =*An. laticincta* Dours, 1869 **n. syn.**; =*An. procera* Costa, 1883 **n. syn.**; =*An. flavescens* Gribodo, 1893 [as *nigrocincta* ssp.] **n. syn.**) **(457, 460, 462, 557)**
subterranea Gistel, see *dalmatiensis* (Strand)
subtorrida (Cockerell), 1946 Am (An), E **(515)**
sumatrana Lieftinck, 1956 Am, O **(513)**
superans Walker, 1871 An, P **(472, 474, 476)**
superba Friese, see *epichariformis* Gribodo
supraferrea (Cockerell), 1946 Am (An), E **(504)**
sutepensis Cockerell, 1929 Ha, O
suworzevi Morawitz, 1888 An, P **(462)**
sybilae (Rayment), 1944 Am (An), A, publication date is not 1942 **(512)**
syriaca Friese, 1922 An, P **(476)**
syringae Cockerell, see *terminalis* Cresson
tadzhica Popov, 1948 Ha, P
tainana Strand, see *calceifera* (Cockerell)
tainanicola (Strand), 1913 Ha (An), O (=*Ha. maiella* Lieftinck, 1974 [as *tainanicola* ssp.] **n. syn.**)
talaris (Pérez), 1895 Am (An), P **(504)**
tarsalis Priesner, 1957 An, P **(492)**
tarsata (Spinola), 1838 Ha *(Tetralonia),* P (=*Habrophora* [sic] *ezonata* Smith, 1854; =*An. passerini* Sichel, 1856) **(447)**
tarsata Dours, see *californica* Cresson **(557)**
tarsidens Fedtschenko, 1875 An, P **(476)**
taurea Say, 1837 (An) =*Melitoma* (Anthophoridae; Emphorini) (=*An. fulvifrons* Smith, 1854)
taurica Friese, see *podagra* Lepeletier

tecta Smith, see *dufourii* Lepeletier
tedshenensis Radoszkowsky, 1893 An, P (=*Po. tedthenensis,* [sic] Dalla Torre, 1896) **(476)**
tekkensis Gussakovsky, 1935 Un (An), P **(450)**
tellervo Strand, see *acraensis* (Fabricius) **(506)**
tenella (Klug), 1845 An *(Saropoda),* P **(492)**
teneriffensis Cockerell, see *quadrifasciata* (de Villers)
tenuiciliata Alfken, see *albosignata* Friese
terminalis Cresson, 1869 An, N (=*An. pernigra* Cresson, 1879 **n. syn.** [black form]; =*Ceratina bidentata* Provancher, 1882; =*An. nudata* Provancher, 1888; *An. subglobulosa* Provancher, 1888; =*Po. syringae* Cockerell, 1898 **n. syn.**; =*An. nubiterrae* Viereck, 1903; =*Clisodon neofurcata* Sladen, 1919 **n. syn.**; =*Po. sibiricus* Gussakovsky, 1932 **n. syn.**; =*Clisodon sperryi* Cockerell, 1937 [as *terminalis* ssp.] **n. syn.** [red form]) **(449, 486–489)**
terminata (Smith), 1879 Am (An), E (no. 5, not no. 4) **(506)**
terminata Smith, see *aurulentocaudata* (Dours)
ternatensis (Cockerell), 1910 [as *zonata* ssp.] Am (An), A **(511)**
tersa Erichson, see *altaica* Radoszkowsky
testaceipes Morawitz, 1888 An, P **(462)**
tetra Friese, see *armata* Friese
tetradonta Cockerell, 1933 An, E (=*An. livingstonei* Cockerell, 1938 **n. syn.**; =*An. aureohirta* Cockerell, 1946 **n. syn.**) **(491,492)**
tetrataeniata (Gribodo), 1894 Am (An), P **(505)**
texana Cresson, see *californica* Cresson
thalassiana Cockerell, see *porterae* Cockerell
thomsoni Saunders, 1882 An, P **(496)**
thorogoodi (Rayment), 1939 Am (An), A **(511)**
tibialis Morawitz, 1894 An, P **(492)**
tienmushanensis Wu, 1979 *Elaphropoda,* P
tinctula Cockerell, see *peritomae* Cockerell
tinsleyella Rayment, see *chlorocyanea* (Cockerell)
tomentosa Mocsáry, see *podagra* Lepeletier
tomentosa Friese, see *festivus* (Dours)
torensis (Priesner), 1957 Am (An), P **(515)**
torrida Smith, see *calens* (Lepeletier)
torridella Meade-Waldo, see *pygmaea* Meade-Waldo
townleyella Rayment, see *pulchra* (Smith)
triangulifera (Cockerell), 1933 Am (An), E (=*An. luluana* Cockerell, 1933 **n. syn.**) **(506)**
trichopus Hedicke, 1940 An, P **(496)**
trichroma Friese, see *dorsalis* Vachal
tricincta Friese, see *arequipensis* Brèthes
tricolor (Fabricius), 1775 An *(Andrena),* T (=*Megilla nigrita* Fabricius, 1804 **n. syn.** [dark form]; =*An. krugii* Cresson, 1878) **(466, 468, 535)**
tridentata (Friese), 1899 An (Po), EP **(492)**
tridentella Priesner, 1957 An, P **(492)**
trifasciata Radoszkowsky, 1886 An, P **(496)**
trilineata (Pérez), 1906 An (Saropoda), P **(492)**
tristissima (Cockerell), 1904 [as *infernalis* ssp.] Ha *(Emphoropsis)* **n. comb.,** dark form, N (=*Emphoropsis interspersa* Cockerell, 1905 **n. syn.**; =*Emphoropsis rugosissima* Cockerell, 1905 **n. syn.**) **(447)**
tristrigata Spinola, 1851 (An) =*Alloscirtetica* (Anthophoridae; Eucerini)
trochanterica Morawitz, 1888 An, P **(476)**
tschelcarica Ponomareva, see *retusa* (Linnaeus)
tsushimensis Cockerell, see *florea* (Smith)
tuberculilabris Dours, 1869 An,E **(492)**
tubifera (Cockerell), 1933 Am (An), E **(515)**
tumidifrons Lieftinck, 1974 Ha, O
tunicata Gistel, 1857 Un (An), P **(450)**
turanica Fedtschenko, see *plagiata* (Illiger)
turcomanica Morawitz, 1888 An, P **(464–466)**
turneri Cockerell, 1909 Ha, O
ugandae Meade-Waldo, see *acraensis* (Fabricius)
uljanini Fedtschenko, 1875 An, P **(460)**
uniciliata Sichel, 1860 Un (An), P **(450)**
unicincta Friese, see *somalica* (Magretti)
unicolor (Saussure), 1890 *Pachymelus* (Ha) **n. comb.,** E
unispina Wu, see *iole* Bingham
unistrigata Dours, 1869 Un (An), T **(450)**
urbana Cresson, 1878 An, N (=*Po. alamosanus* Cockerell, 1896; =*An. catalinae* Cockerell, 1899 **n. syn.** [red form]; =*An. nebracensis* Swenk, 1909 **n. syn.**; =*An. leucostomella* Cockerell, 1923 **n. syn.**; =*An. clementina* Cockerell, 1939 [as *catalinae* ssp.] **n. syn.** [red form]; =*An. nicolai* Cockerell, 1939 **n. syn.** [red-yellow form]) **(456, 466, 468, 469, 489)**
urens (Cockerell), 1911 Am (An), O **(513, 556)**
ursina Cresson, 1869 An, N (=*An. pyralitarsis* Dours, 1869; *An. simillima* Cresson, 1878 **n. syn.**; =*An. euops* Cockerell, 1903 **n. syn.**; =*An. californiensis* Michener, 1936 [as *simillima* ssp.] **n. syn.** [dark form]) **(465, 466)**
usbekistana Cockerell, 1930 An, P **(496)**
usticauda Cockerell, 1912 An, T (=*An. cinerior* Cockerell, 1949 [as *usticauda* ssp.] **n. syn.**) **(496)**
utahensis Michener, see *porterae* Cockerell
valga (Klug), 1845 An *(Megilla),* P **(473, 476)**
vallorum (Cockerell), 1896 An (Po), N **(454, 476, 478, 480, 481, 555)**
vanderysti (Cockerell), 1936 Am (An), E **(504)**
vannigera Timberlake, 1951 An, N **(460, 462, 556)**
vara Lepeletier, see *quadrimaculata* (Panzer)
varians Friese, see *plumipes* (Pallas)
varicolor Illiger, 1806 *(Megilla) nomen nudum*
variipes Morawitz, 1894 Un (An), P **(450)**
vedettus Nurse, see *atroalba* Lepeletier
vegeta (Bingham), 1896 Am (An),O **(511)**
velocissima (Fedtschenko), 1875 Am (An), OP **(510)**
velutina (Friese), 1909 Am (An), E **(510)**
venerabilis Cockerell, see *lanata* (Klug)
ventilabris Lepeletier, 1841 An, P (=*An. nigrocinctula* Dours, 1869 **n. syn.**) **(464)**
ventiscopula Wu, 1984 Ha, P
ventralis Michener, see *cressonii* (Dalla Torre)
vernalis Morawitz, 1878 An, P **(462)**
vernayi Cockerell, see *xanthostoma* Cockerell
versicolor Friese, 1925 An, T **(468)**
vestibula Cockerell, see *vestitula* (Cockerell)
vestita Morawitz, see *vestitella* Brooks **(474)**
vestita Smith, 1854 An, E (=*Podalarius* [sic] *pallidicinctus* Cameron, 1905 **n. syn.**; =*An. laticeps* Friese, 1911 **n. syn.**; =*An. griseovestita* Cockerell, 1914 **n. syn.**; =*An. ampliceps* Friese, 1915 [n. name for *An. laticeps* Friese, 1911, not Friese, 1905] **n. syn.**; =*An. sinuatitarsis* Friese, 1925 **n. syn.**; =*An. greyae* Cockerell, 1931 **n. syn.**) **(446, 492, 495, 543, 557)**

vestitella Brooks An, P, n. name for *An. vestita* Morawitz, 1888, Horae Soc. Entomol. Ross. 22:232, not Smith, 1854 **(474, 476)**
vestitula (Cockerell), 1936 Am (An), E (=*An. vestibula* [sic] Cockerell, 1946) **(515)**
vetula Eversmann, see *senilis* Eversmann
vetula Klug, 1845 Un *(Megilla),* P **(450)**
victoriensis (Rayment), 1951 Am *(Asaropoda),* A **(515)**
vidua (Klug), 1845 An *(Megilla),* P (=*An. boops* Alfken, 1926, [dark form]; =*An. fumipennis* Alfken, 1926 **n. syn.** [dark form]) **(473, 474, 476)**
vierecki (Cockerell), 1909 Ha *(Emphoropsis)* **n. comb.,** N
vierecki Cockerell, see *centriformis* Cresson
vigilans (Smith), 1861 Am (An), O **(513)**
vigilans Smith, see *custos* (Dalla Torre)
villosa Herrich-Schaeffer, see *plagiata* (Illiger)
villosula Smith, see *plumipes* (Pallas) **(460)**
violacea (Lepeletier), 1841 Am (An), O (=*Megilla albopunctata* Illiger, 1806 *nomen nudum,* **n. syn.**; =*An. anthracina* Gribodo, 1893 [as *violacea* ssp.] **n. syn.**) **(450, 512, 513)**
virgo Gribodo, 1893 (An) =*Centris muralis* Burmeister, 1876 (Anthophoridae; Centridini)
vivida (Smith), 1879 Am (An), E **(506)**
vividula Strand, see *cincta* (Fabricius)
volucellaeformis Dours, 1869 Un (An), T **(450)**
vulpina Panzer, see *quadrimaculata* (Panzer) **(486, 489)**
wadicola Alfken, 1935 An, P **(486)**
walkeri (Cockerell), 1905 Am (An), O (=*An. darwini* Cockerell, 1910 **n. syn.**) **(510, 511)**
wallacei (Cockerell), 1907 Am (An), A **(511)**
wallaciella Rayment, see *perpulchra* (Rayment)
walshii Cresson, 1869 An, N **(466, 468, 469)**
waltoni Cockerell, 1910 [as *vulpina* ssp.] An, O **(486)**
wartmanni Friese, 1905 An, E **(492)**
washingtoni Cockerell, see *crotchii* Cresson
watsoni Cockerell, see *porterae* Cockerell
wegelini Friese, 1914 An, P **(486, 489)**
wegeneri Friese, see *alternans* (Klug)
whiteheadi (Cockerell), 1910 [as *zonata* ssp.] Am (An), O **(511)**
whiteleyella (Rayment), 1947 Am (An), A **(511)**
wickwari Bingham, 1908 (Po) =*Eucara* (Anthophoridae; Eucerini) **n. comb.**
willingi Cockerell, see *bomboides* Kirby
wuae Brooks An, P, n. name for *Anthomegilla sinensis* Wu, 1982, not *Ha. sinensis* Alfken, 1937, Entomology and Phytopathology 5:404-405 or *Clisodon sinensis* Wu, 1982, Insects of Xizang, vol. II:419 **(482)**
xanthochlora Cockerell, 1923 An, T **(496)**
xanthostoma Cockerell, 1932 An, E (=*An. vernayi* Cockerell, 1935 **n. syn.** The female holotype of *vernayi* (Transvaal) has the metasoma of a species of *Tetralonia* glued onto it; the same metasoma described in the original description; =*An. heteropoda* Cockerell, 1946 [as *vernayi* ssp.] **n. syn.**) **(492)**
xerophila (Cockerell), 1911 [as *quadrifasciata* ssp.] Am (An), O **(505)**
xinjiangensis (Wu), 1985 An *(Clisodon),* P **(489)**
xizangensis Wu, 1979 Ha, P
yunnanensis Wu, 1983 Ha, P
yunnanensis Wu, 1983 Am, P **(513)**
zamoranella Cockerell, 1949 An, T **(496)**
zanoni Gribodo, 1924 An, P (=*An. borgensis* Priesner, 1957 [as *zanoni* ssp.] **n. syn.**) **(486)**
zhejiangensis Wu, see *imitatrix* Lieftinck
zimini Gussakovsky, 1935 An, P **(496)**
zinniae (Cockerell), 1932 Am (An), E **(504)**
zombana Cockerell, 1910 An, E **(492)**
zonata (Linnaeus), 1758 Am *(Apis),* O (=*An. nigritarsis* Dover, 1924 **n. syn.**; =*An. doveri* Cockerell, 1931, n. name for *An. nigritarsis* Dover, 1924, not Friese, 1905 **n. syn.**) **(509-511)**
zonatula Smith, 1854 Ha (*Habrophora* [sic]), P

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By
Arturo Roig-Alsina

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A Revision of the Bee Genus *Doeringiella* (Hymenoptera, Anthophoridae, Nomadinae)[1]

Arturo Roig-Alsina[2]

ABSTRACT

This is a revision of the genus of cleptoparasitic bees *Doeringiella* Holmberg. These bees occur in southern South America, with maximal diversity in the xeric regions of northwestern and west-central Argentina. Thirty-one species are recognized, sixteen of which are described as new. The previous subgeneric classification is abandoned; one of the two subgenera has no basis for being maintained and the other is synonymized with *Pseudepeolus*, which is recognized as the sister group of *Doeringiella*. A phylogenetic analysis uses *Pseudepeolus* and *Triepeolus* as the closest outgroups. A key to the species, descriptions and illustrations are provided.

INTRODUCTION

Doeringiella is a genus of cleptoparasitic bees of the tribe Epeolini. It is South American with species distributed in Argentina, Chile, Bolivia, Perú, Paraguay, Uruguay and southeastern Brazil. The highest diversity is found in the xerophytic region of northwestern and west-central Argentina, where 24 species occur.

This genus has been noted by melittologists since its very first description for the conspicuously swollen scapes of some males. Aside from this character it looks very much like the more widespread *Triepeolus*, to which it is closely related.

Some early authors such as Friese, Brèthes, Jörgensen and Schrottky did not accept Holmberg's genus and treated its species as belonging to *Epeolus*, a extreme view that has been recently revived by Warncke (1982). *Doeringiella* differs from *Epeolus* in important characters of male genitalia and female apical sterna. *Doeringiella* was recognized by Cockerell (1917, 1922), Michener (1944) and Moure (1954). The number of epeoline genera that should be recognized is not considered here; I have followed the generic arrangement proposed by Moure in his characterization of South American Epeolini. He pointed out some useful characters to distinguish *Doeringiella* from *Triepeolus*: *Doeringiella* has supra-antennal areas depressed, pedicel fully exposed, two maxillary palpal segments and vestigial basitibial plates present in both sexes. The male genitalia and the female apical sterna indicate the close relationship of these two genera and *Pseudepeolus*.

Moure (1954) divided *Doeringiella* into the nominal subgenus and two new subgenera, *Orfilana* and *Stenohisa*. *Doeringiella* proper was

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characterized by males with swollen scapes and females with the pseudopygidial area reduced, *Orfilana* by males with normal scapes and females with pseudopygidial area conspicuous. As will be shown below, especially in the phylogenetic analysis, this set of characters does not hold; only a subset of the species with swollen male scape has reduction of the female pseudopygidial area; furthermore a swollen scape seems to have evolved twice. Therefore *Orfilana* is not recognized as different from *Doeringiella* sensu stricto. *Stenohisa* is a junior synonym of *Pseudepeolus* Holmberg (new synonymy). It is a distinctive group, and I consider that it merits as much recognition as *Doeringiella* and *Triepeolus*; its species are not included in the present revision.

Some taxa have been misplaced in *Doeringiella*. The genus was misunderstood by Friese (1908), who used the name to describe several species currently in *Brachynomada*. Holmberg described 5 species in *Doeringiella*, of which 3 are recognized in this revision. *D. nemoralis* should be called *Triepeolus nemoralis* (Holmberg) (new combination), and *D. silvatica* does not correspond to any specimens I have studied (see comments under *holmbergi*). *D. angustata* should be called *Pseudepeolus angustatus* Moure (new combination).

The only certain information on the biology of *Doeringiella* comes from the observations of Claude-Joseph (1926) on *gayi* and its host *Svastrides melanura*. He described and figured the larva. Michener (1953), based on that description, mentioned the similarity of the larva of *gayi* to larvae of Nearctic species of *Triepeolus*. Claude-Joseph (1926) also observed *gigas* entering nests of *Caupolicana gayi*. Other hints on the host relations of *Doeringiella* are indirect, and suggest anthophorid hosts. Holmberg (1886a) observed that *bizonata* was abundant in places where *Svastra bombylans* was also common. This observation is coincident with the large series of both species collected in the same places and times that are preserved in the Snow Entomological Museum, University of Kansas, Lawrence. In the same paragraph Holmberg mentions *holmbergi* (as *variegata*) approaching the nest of an unidentified anthophorid. Jensen-Haarup (1908) and Jörgensen (1909, 1912a) reported *burmeisteri* flying over aggregations of *Melissoptila dama*, and Jörgensen (1912b) recorded *Diadasia pereyrae* as another suspected host.

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MATERIAL AND METHODS

The morphological terminology of Michener (1944, 1965) has been followed, except that metapostnotum is used instead of propodeal triangle (Brothers, 1976), and the term *plical surface* is used for a more accurate description of the scape (see character m below). The upper interocular distance has been measured along the lower tangent of the anterior ocellus. In the keys I have made extensive use of color and vestiture; these features are notably constant within most species. In the descriptions the metasomal terga (T) and sterna (S) are identified with Arabic numerals. Under Material Studied, females and males are indicated by F and M respectively.

For easy comparison characters have been grouped and lettered in the descriptions. Characters a, b, c, d, e, j, k, l, n, o and s are applicable to both sexes, but will be found under the female description unless this sex is unknown. When only males were available for description, charac-

ters that refer to the female (f, g, h, i, m, p, q, r) are omitted. Some letters denote characters present in a few taxa and will be found only when pertinent. The following is a comprehensive list of characters utilized:

(a) Coloration of integument and wings.

(b) Vestiture. Color, length and density of body hairs, except those of maculations.

(c) Maculations. Many epeolines have characteristic patches of pale, dense, appressed hairs; distribution of the patches is more or less constant within a genus. The names applied to these maculations can be seen in figure 12 (shaded areas). Bands and spots can vary in extent, shape and coloration.

(d) Punctation. Measurement of punctures was on the middle part of the mesepisternum, below the mesepisternal band of hairs, or equivalent position when the band is absent. Punctation of other parts of the body is indicated by comparison to this sector.

(e) Metapostnotum and propodeum. The posterior face of the propodeum that surrounds the triangular metapostnotum is diagnostic, varying in the extent of punctured areas and the kind of hairs.

(f, u) Head measurements of female and male, respectively. Two proportions are useful for description of head shape: proportion of lower interocular distance (LID) to upper interocular distance (UID) and proportion of antennocular distance (AOD) to interantennal distance (IAD).

(g) Supra-antennal, paraocular and ocellocular areas in the female. Degree of depression.

(h) Frontal carina. Extent and conformation.

(i) Paraocular carina. Extent.

(j) Preoccipital carina. The genal and upper sectors of the carina are united at an angle, characteristic of the genus (fig. 13); the upper sector may be weak or may disappear near the angle.

(k) Supraclypeal area. Usually swollen, forming the transition between the frontal carina and the clypeus, but in a few cases flat or depressed.

(l) Labrum. Proportions and sculpture.

(m, v) Antenna of female and male, respectively. Relative lengths of scape, upper interocular distance (UID) and the two first flagellomeres are given. Scape length does not include the basal bulb; flagellomeres were measured on the shortest side. Description of scape. As the antenna rotates when it is extended, it is confusing to speak about upper and lower or inner and outer sides. The antennal surface that is held against the face when the antenna is directed backwards becomes the outer surface when the antenna is directed forwards; this is easily seen by the position of the cavity in the swollen scape of some males. To avoid this problem the surface of the scape toward which the flagellum is flexed is called the plical surface (fig. 14). The plane in which the flagellum moves is perpendicular to the plane formed by two points on the upper rim of the scape: the monocondylic articulaton between scape and pedicel and a conspicuous notch just opposite it.

(n) Shape of scutellum and axilla.

(o) Spiracular carina, conformation. This is an arched carina above the propodeal spiracle; sometimes it is continued along the posterolateral angle of the propodeum.

(p) Sternum 5 of female, shape.

(q) Tergum 5, of female, pseudopygidial area and basal patch of hairs.

(r, x) Middle and hind legs of female and male, respectively.

(s) Wing venation. The length of vein r is compared to the basal width of the second submarginal cell.

(t) This letter is used to indicate color and vestiture of male when they differ from those of the female.

(w) Sternum 5 of male, fringe of hairs.

(y) Penis.

CLADISTIC ANALYSIS

The analysis of polarity of characters is based on a preliminary study of the generic classification of the Epeolini. *Doeringiella* and *Pseudepeolus* together are considered the sister group of *Triepeolus*. *Thalestria* and *Rhinepeolus* are considered more closely related to those three genera than to other Epeolini. This working hypothesis has allowed the polarization of 24 characters within *Doeringiella* (Table 1). In this list general statements about the outgroups refer to all the tribe Epeolini except *Doeringiella*.

Most of the characters listed by Moure to define *Doeringiella* are symplesiomorphies, with exception of the strong frontal carina and depressed supra-antennal areas. The following is a list of the synapomorphies that support the genus. Some do not hold in the whole group and are thought to have reverted. 1-Articulating surfaces of penis and penis valves recurved (fig. 59). 2-Preoccipital carina forming a conspicuous angle near upper corners of head (fig. 13); only one species (*chacoensis*) nearly lacks the angle. 3-Scape of both sexes (except those males with swollen scape) with a sub-basal angle (fig. 14); only one species (*joergenseni*) has reverted in this feature. 4-Middle femur of males with long hairs on underside; exception is *chacoensis*. 5-Metapostnotum almost bare, a few hairs restricted to upper corners; exceptions are *guttata* and *oblata*, which have evenly distributed hairs. Some other characters not found outside *Doeringiella* are present in some of the species; striking characters of this type are the swollen scape of some males (figs. 45-55) and the basal patch of hairs on T5 of the female (fig. 4). Other such characters are the depressed supra-antennal areas and the distribution of hairs on the lateroventral surface of the gonostylus, leaving a bare patch (figs. 65-68, 71)

(the plesiomorphic condition is even distribution of hairs).

The cladograms (fig. 1) were prepared with the help of the computer program PAUP (Swofford, 1985). Some species are known from one sex only, so their positions in the cladogram are tentative; they are indicated with dashed lines. PAUP produced several equally parsimonious trees. The minimum tree length obtained with data detailed in table 2 was 55 steps.

The position of *holmbergi* and the structure of branch C remain invariant through all the analyses (fig. 1a). Branch B is also almost invariant, with the exception, explained below, of *pilicornis* and *speciosa*. Major differences are due to the position of the *simplicicornis-similaris* branch that appears alternatively as the sister group of branch AB, of B or of A (figs. 1a, 1b, 1c). These two species are similar in genitalic structure to the species in a basal group in branch A, especially

Table 1. List of apomorphous characters

1. Scape of female with sub-basal angle on plical surface (figs. 14, 22a, 23a) (1). Sub-basal angle absent in outgroups; absent also in *joergenseni*.

2. Scape of female with longitudinal keel delimiting plical surface on one side (fig. 14) (1). No such keel in outgroups.

3. Apical third of female scape with plical surface concave (1). Apical third round or oval in cross-section in outgroups. In some *Pseudepeolus* the scape is flattened, but in a different plane.

4. Scape of male swollen (1). No such scape in outgroups.

5. Scape of male with open cavity (fig. 51) (1). With cavity wider than entrance hole (fig. 46) (2). No cavity in outgroups.

6. Scape of male with long, erect hairs on plical surface (1). Hairs short and appressed in *Pseudepeolus* and usually so in *Triepeolus*. The presence of such a bunch of hairs is particularly conspicuous in those species with short, appressed body vestiture, but in some species with long, erect body vestiture (*angulicornis*, *gayi*, *tricolor*) the homology is not clear.

7. Dorsal edges of penis not sclerotized on basal 0.15-0.30, lateral view as in figures 58, 60 (1). Not sclerotized on basal 0.40-0.65, lateral view as in figures 61-63 (2). In outgroups dorsal edges of penis continuously sclerotized from base towards apex. The plesiomorphic condition is present in *holmbergi* and the *bizonata* group (figs. 56-57).

8. Dorsal edges of penis each with lamella present, as in figure 61 (1). This lamella placed towards apex of nonsclerotized portion, as in figure 62 (2). Lamella forming projection, as in figure 63 (3). Lamella absent in outgroups.

9. Dorsal edges of penis converging medially, as in figures 58-63 (1). Dorsal edges separated in outgroups; condition also present in *holmbergi* and *bizonata* group (figs. 56-57).

10. Articulating surfaces of penis and penis valves (fig. 59) recurved and perpendicular to longitudinal axis of penis (1). Such recurved surfaces oblique to longitudinal axis (2). *Pseudepeolus* and *Triepeolus* have articulating surfaces not recurved, and line of articulation perpendicular to longitudinal axis.

11. Penis valve as in figure 72 (1). Penis valve as in figures 73-75 is closer to shape found in *Pseudepeolus* and *Triepeolus*.

12. Volsella reduced, membranous, not hairy (1). Presence of volsella is considered plesiomorphic. Most species of *Doeringiella* have a conspicuous, hairy volsella.

13. S8 of male as in figure 64b (1). This shape of sternum is not found outside group of *arechavaletai*, *paranensis*, *gigas* and *cochabambina*.

14. Sternum 5 of female bent down apically, usually more or less flattened preapically and bent up in sharp angle laterally (1). S5 not bent down apically in *Pseudepeolus* and most *Triepeolus*. Species of *Triepeolus* with S5 convergently bent down apically can be considered derived on the basis of other features.

15. S5 narrowed apically, as in figure 44 (1). Synapomorphy for *hebes* and *centuncula*.

16. Pseudopygidial area reduced to ill-defined apical band, length 0.2-0.4 times apical width (1). Pseudopygidial area well developed in outgroups.

17. Pseudopygidial area with slender hairs (fig. 4) (1). Pseudopygidial hairs variously modified in *Triepeolus*, but a pseudopygidial area with stiff hairs as in figures 2-3 is basic for *Doeringiella*, *Pseudepeolus* and *Triepeolus*, although derived relative to other bees.

18. T5 of female with hairs densest on basal central area (1). Hairs on basal central area forming a definite patch (fig. 4) (2). T5 with hairs not differentiated in outgroups.

19. Supraspiracular carina reduced (1). Such carina well developed in *Pseudepeolus* and *Triepeolus*.

20. Hairs on metapostnotum restricted to upper corners or absent (1). Hairs more evenly distributed on metapostnotum in *Pseudepeolus* and usually in *Triepeolus*.

21. Preoccipital carina well marked, continuous (1). Preoccipital carina absent near upper corners of head in *Pseudepeolus* and *Triepeolus*.

22. Upper sector of preoccipital carina absent (1). Plesiomorphic condition as in 21.

23. Middle femur of male with long hairs on underside (1). Short, appressed hairs in *Pseudepeolus*, *Triepeolus* and *D. chacoensis*.

24. Axilla projected as strong tooth, as in figures 27, 30, 31, 35 (1). Such strong tooth not found outside *bizonata* group of *Doeringiella* and in *Pseudepeolus*; variable in *Triepeolus*.

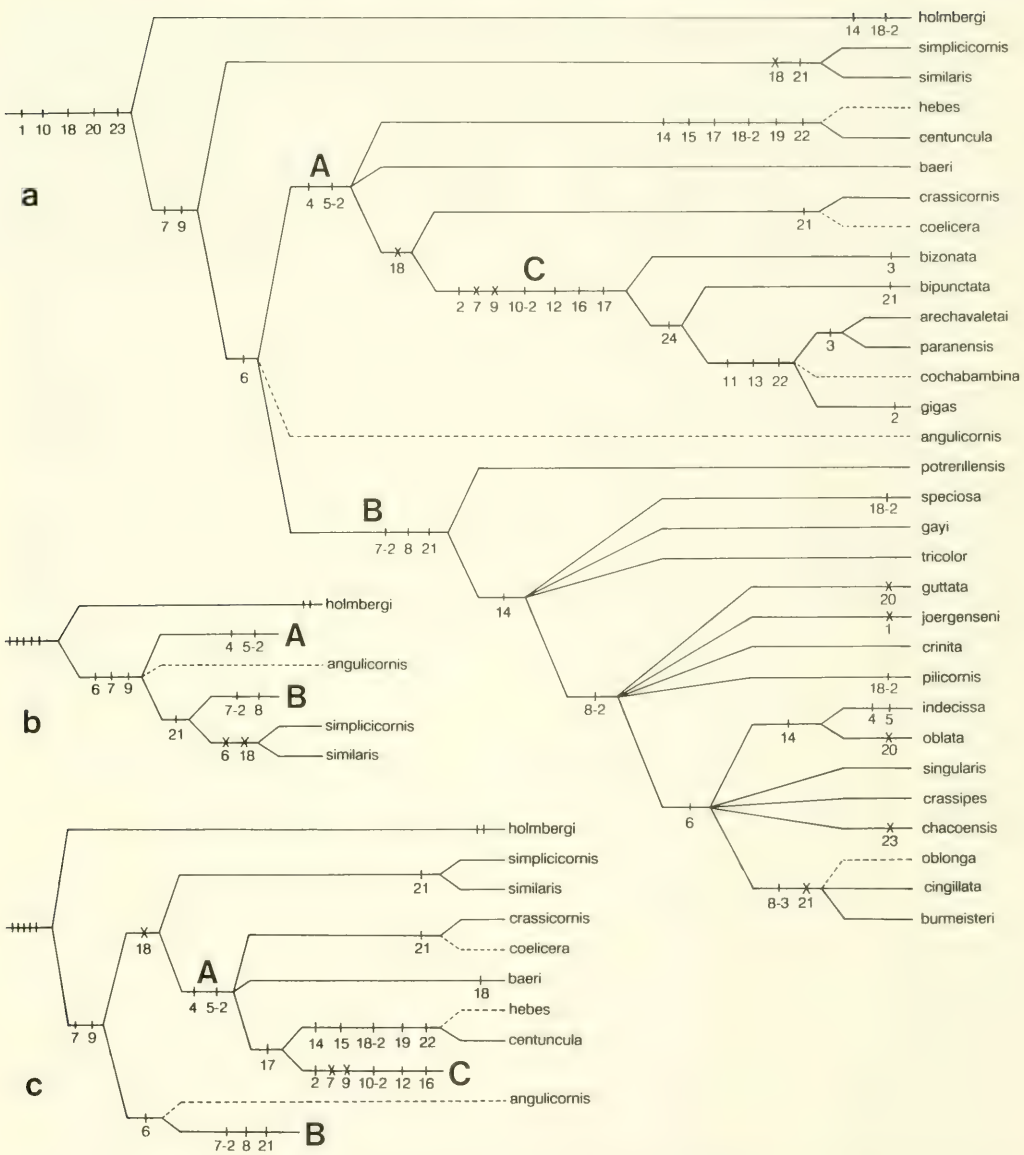


Fig. 1. Cladograms showing the interrelationships of the species of *Doeringiella*. Dashed lines indicate species with only one sex known. Bars indicate apomorphies, crosses indicate reversals. Characters are numbered according to Table 1 and are all synapomorphies at least somewhere in the genus. Autapomorphies are omitted. **a** shows all species, **b** and **c** are alternatively equally parsimonious topologies for the basal part of the cladogram.

crassicornis. It is interesting to note that the pair *simplicicornis-similaris* and *holmbergi* have the female scape flattened on the plical surface, a character usually present in species whose males have swollen scapes; this character has not been coded due to presence of intermediate states both in branch A and in B. *D. angulicornis* changes in position with that of the previous two taxa. It has a unique scape (fig. 24); the genitalia suggest *baeri*, a species that it strikingly resembles in coloration. The discovery of the female of *angulicornis* will help to clarify its position.

The basal position of *holmbergi* as sister species of all other taxa seems reasonable since its genitalia are clearly plesiomorphic, closely approaching those of *Triepeolus* and *Pseudepeolus*.

Table 2. Data matrix for *Doeringiella* species. Characters and codes are indicated in Table 1. The hypothetical ancestor is plesiomorphic in all characters. 9 represents missing data.

Character	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Ancestor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
bizonata	1	1	1	1	2	9	0	0	0	2	0	1	0	0	0	1	1	0	0	1	0	0	1	0
arechavaletai	1	1	1	1	2	9	0	0	0	2	1	1	1	0	0	1	1	0	0	1	0	1	1	1
paranensis	1	1	1	1	2	9	0	0	0	2	1	1	1	0	0	1	1	0	0	1	0	1	1	1
bipunctata	1	1	0	1	2	9	0	0	0	2	0	1	0	0	0	1	1	0	0	1	1	0	1	1
gigas	1	0	0	1	2	9	0	0	0	2	1	1	1	0	0	1	1	0	0	1	0	1	1	1
cochabambina	9	9	9	1	2	9	0	0	0	2	1	1	1	9	9	9	9	9	0	1	0	1	1	1
crassicornis	1	0	0	1	2	9	1	0	1	1	0	0	0	0	0	0	0	0	0	1	1	0	1	0
indecissa	1	0	0	1	1	9	2	2	1	1	0	0	0	0	0	0	0	1	0	1	1	0	1	0
baeri	1	0	0	1	2	9	1	0	1	1	0	0	0	0	0	0	0	1	0	1	0	0	1	0
coelicera	9	9	9	1	2	9	1	0	1	1	0	0	0	9	9	9	9	9	0	1	1	0	1	0
angulicornis	9	9	9	0	0	1	1	0	1	1	0	0	0	9	9	9	9	9	0	1	0	0	1	0
centuncula	1	0	0	1	2	9	1	0	1	1	0	0	0	1	1	0	1	2	1	1	0	1	1	0
hebes	1	0	0	9	9	9	9	9	9	9	9	9	9	1	1	0	1	2	1	1	0	1	9	0
simplicicornis	1	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	1	1	0	1	0
similaris	1	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	1	1	0	1	0
holmbergi	1	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	2	0	1	0	0	1	0
potrerillensis	1	0	0	0	0	1	2	1	1	1	0	0	0	0	0	0	0	1	0	1	1	0	1	0
oblata	1	0	0	0	0	0	2	2	1	1	0	0	0	0	0	0	0	1	0	0	1	0	1	0
gayi	1	0	0	0	0	1	2	1	1	1	0	0	0	1	0	0	0	1	0	1	1	0	1	0
tricolor	1	0	0	0	0	1	2	1	1	1	0	0	0	1	0	0	0	1	0	1	1	0	1	0
speciosa	1	0	0	0	0	1	2	1	1	1	0	0	0	1	0	0	0	2	0	1	1	0	1	0
singularis	1	0	0	0	0	0	2	2	1	1	0	0	0	1	0	0	0	1	0	1	1	0	1	0
crassipes	1	0	0	0	0	0	2	2	1	1	0	0	0	1	0	0	0	1	0	1	1	0	1	0
burmeisteri	1	0	0	0	0	0	2	3	1	1	0	0	0	1	0	0	0	1	0	1	0	0	1	0
cingillata	1	0	0	0	0	0	2	3	1	1	0	0	0	1	0	0	0	1	0	1	0	0	1	0
oblonga	9	9	9	0	0	0	2	3	1	1	0	0	0	9	9	9	9	9	0	1	0	0	1	0
chacoensis	1	0	0	0	0	0	2	2	1	1	0	0	0	1	0	0	0	1	0	1	1	0	0	0
guttata	1	0	0	0	0	1	2	2	1	1	0	0	0	1	0	0	0	1	0	0	1	0	1	0
joergenseni	0	0	0	0	0	1	2	2	1	1	0	0	0	1	0	0	0	1	0	1	1	0	1	0
crinita	1	0	0	0	0	1	2	2	1	1	0	0	0	1	0	0	0	1	0	1	1	0	1	0
pilicornis	1	0	0	0	0	1	2	2	1	1	0	0	0	1	0	0	0	2	0	1	1	0	1	0

Branch A has two possible configurations (figs. 1a, 1c) according to interpretation of characters 17 and 18. All its species are characterized by the swollen male scape and the peculiar cavity that it contains. A swollen scape has appeared twice; it also occurs in *indecissa*. The different structure of the cavity in the two cases supports the idea of convergent origin. Within branch A, *centuncula* and *hebes* are united by several synapomorphies in spite of the fact that the male of *hebes* is not known; it is predicted to have swollen scapes. The preferred cladogram in figure 1a assumes parallel loss of the basal patch of hairs on T5 of the female (character 18). The alternative shown in cladogram 1c assumes one loss and later regaining (in *baeri* and *hebes-centuncula*); this is unlikely (Dollo's rule).

Branch C, the *bizonata* group, contains large bees with specialized features. Synapomorphies are the reduced pseudopygidial area (character 16), the recurved base of the penis oblique to the longitudinal axis (character 10), the membranous volsella (character 12) and the longitudinally keeled scape of the female (character 2). On the other hand the group shows probably plesiomorphic features in the male genitalia (characters 6, 8), interpreted here as reversals. The group *arechavaletai*, *paranensis*, *gigas* and *cochabambina* form a further derived cluster.

Branch B is a phenetically homogeneous group; the most meaningful characters are related to modification in male genitalia. The positions of *speciosa* and *pilicornis* vary according to interpretation of character states 8-2 and 18-2, whether one or the other is considered to have evolved only once or in parallel. The preferred cladogram shown in figure 1a assumes that the genitalic structure represented by state 8-2 is a synapomor-

phy, and the patch of hairs on female T5, which also appears twice elsewhere in the cladogram, is convergent in *speciosa* and *pilicornis*. The apparent close relationship between *oblata* and *indecissa*, supported by two losses (reversals of characters 6 and 14), is doubtful. Both are distinctive species, particularly *oblata* is highly derived. Although they clearly belong in branch B and its further branch defined by character 8-2, their relationship within that branch remains obscure.

Genus *Doeringiella*

Doeringiella Holmberg, 1886a: 151-152. Type species *Doeringiella bizonata* Holmberg, by monotypy.

Orfilana Moure, 1954: 266-267. Type species *Doeringiella variegata* Holmberg (preoccupied, = *Epeolus holmbergi* Schrottky), by original designation. **Synon. nov.**

Diagnosis. Medium to large epeoline bees similar to *Triepeolus*; supra-antennal areas depressed and frontal carina strong; scape with sub-basal angle, except in those males with swollen scape; preoccipital carina forming sharp angle near upper corners of head; metapostnotum usually bare; middle femur of males with long hairs on underside.

KEY TO THE SPECIES OF *DOERINGIELLA*

Females

1. Posterior surface of propodeum at sides of metapostnotum with erect, long hairs (fig. 7). In some specimens of *joergenseni* long hairs may be restricted to lower part of posterolateral angles, in this case plical surface of scape bearing erect hairs half as long as apical width of scape 2

—. Propodeum posteriorly with appressed, short hairs (fig. 6); or appressed hairs restricted to posterolateral angles of propodeum. Scape never with erect hairs half as long as apical width of scape. 13

2. Clypeus and supraclypeal area flat, as seen laterally scarcely protruding in front of eyes. Notaular spots elongate, separate (fig. 9). (T1 and T2 with pale apical bands) . . . . . *bizonata*

—. Clypeus and supraclypeal area convex, as seen laterally protruding in front of eyes. Notaular spots contiguous with median scutal line or absent 3

3. Pseudopygidial area reduced to narrow, ill-defined band, 0.2-0.4 times as long as apical width. Length 10-18 mm. 4

—. Pseudopygidial area well defined, 0.6-1.0 times as long as apical width, (figs. 2, 4). Medium-sized species, length 8-11 mm. 7

4. Body wholly black, except hind coxae with white hairs above and T1 band reduced to two lateral white spots. Forewing evenly deeply infuscated, veins dark. Scutellum with longitudinal median impression weak . . . . . *bipunctata*

—. Terga with pale apical bands. Forewing slightly infuscated, usually darker towards apex, veins brownish. Scutellum bigibbous, with strong longitudinal impression 5

5. Scape without longitudinal keel limiting plical surface. Legs and labrum partly light reddish. (Body hairy, with long creamy-yellow hairs on most of head and thorax; T1-T6 largely maculated. Chilean species) . . . . . *gigas*

—. Scape with longitudinal keel limiting plical surface. Legs and labrum dark 6

6. Pale bands absent on T1, complete on T2-T4. Vestiture other than maculations on terga yellowish, on sterna whitish. Hairs around antennal socket whitish . . . . . *paranensis*

—. Pale band on T1 complete or briefly interrupted, on T2 complete to interrupted, on T3 complete, interrupted or absent, on T4 interrupted or absent. Vestiture on terga and sterna other than maculations black. Hairs around antennal socket dark brown. . . . . *arechavaletai*

7. Pseudopygidial area parallel-sided, with slender, dense hairs (fig. 4). S5 narrowed toward apex, truncate (fig. 44). Upper sector of preoccipital carina absent 8

—. Pseudopygidial area trapezoidal or semicircular, with sparser, thick hairs (fig. 2). S5 less narrowed to-

ward apex, evenly rounded (fig. 43). Upper sector of preoccipital carina present at least medially 9

8. Axilla rounded, not produced at all (fig. 37). Scutellum and antenna black. T1 with apical band and also whitish hairs on sides, leaving central, transverse black patch . . . . . *hebes*

—. Axilla triangular, slightly produced (fig. 36). Scutellum, scape, pedicel and first two flagellomeres red. T1 with apical band only, without whitish hairs on sides . . . . *centuncula*

9. Thorax without maculations; T1-T4 with narrow yellowish apical bands to wholly black. Scape without sub-basal angle. (Scape with dense, erect hairs on plical surface and also on opposite surface, as long as half apical width of scape. Metapostnotum delimited by a more or less distinct sulcus). . . . . *jorgenseni*

—. Thorax with maculations, or if not, T1-T2 with wide white apical bands. Scape with sub-basal angle 10

10. Metanotal tuft and hairs on propodeum black; T1-T2 with wide, straight, apical bands; apex of S5 not bent down apically 11

—. Metanotal tuft and hairs on propodeum pale; T1-T4 with apical bands, on T1 usually expanded laterally; apex of S5 bent down apically 12

11. Notaular spots extended laterally, forming single transverse band together with centrally interrupted pronotal band. Flagellum entirely reddish. Labrum with denticles preapical, close together, separated by 0.12-0.16 times labral length (fig 16) . . . . . *baeri*

—. Notaular spots and pronotal band absent. Last 2-3 flagellomeres black. Labrum with denticles separated by 0.20- 0.24 times labral length, close to apical rim (fig. 19) . . . . . *potrerillensis*

12. Maculations creamy-yellowish. Apical band on T1 greatly expanded laterally, leaving a central, semicircular black area; on T2 also expanded laterally. Mesepisternal band complete, of long hairs. Flagellum mostly reddish . . . . . *gayi*

—. Maculations whitish. Apical band on T1 transverse or slightly expanded laterally, on T2 transverse, sometimes interrupted medially. Mesepisternal band interrupted behind level of pronotal lobe, of short hairs. First flagellomere reddish, rest of flagellum black . . . . . *tricolor*

13. Scutellum red. 14

—. Scutellum black 15

14. Pseudopygidial area rounded (fig. 3). Clypeus red. Scutellum clothed with short, white hairs. Metanotal tuft white. (Red on clypeus, scutellum, metanotum and sometimes part of supraclypeal area, metapostnotum and propodeum. Posterior surface of propodeum evenly covered with short, appressed white hairs). . . . . *guttata*

—. Pseudopygidial area truncate. Clypeus black. Scutellum clothed with short, black hairs. Metanotal tuft black. (Tergal bands white, contrasting with the black pubescence of metasoma). . . . . *speciosa*

15. Clypeus flat, supraclypeal area depressed, as seen laterally not protruding in front of eyes. (Posterior surface of propodeum at sides of metapostnotum evenly covered with short, appressed hairs. Notaular spots absent. Forewing with wide, dark band along costal margin; remainder of wings hyaline) . . . . . *oblata*

—. Clypeus and supraclypeal area protruding in front of eyes 16

16. T1 with two central confluent yellowish spots separated from apical margin. Proportion of first and second flagellomeres together to scape 0.79-0.87; scape 0.43-0.48 times UID . . . . . *indecissa*

—. T1 with apical band. Proportion of first and second flagellomeres together to scape 0.90-1.20; scape 0.33-0.41 times UID 17

17. Notaular spots absent. Upper sector of preoccipital carina absent near angle. Mesepisternal, posterior scutal, scutellar and metanotal pale

bands absent. (Narrow pronotal band and hairs around antennal sockets whitish to yellowish; hairs on most of thorax ochraceous. Apical tergal bands yellow, complet on T1-T4) . . . . . *cingillata*

—. Notaular spots present, if not distinct, then occipital carina complete; other maculations of thorax usually present 18

18. Posterior surface of propodeum at sides of metapostnotum with punctures and hairs. Preoccipital carina well developed, complete, angle strong 19

—. Posterior surface of propodeum at sides of metapostnotum bare, without punctures; hairs restricted to posterolateral angles. Preoccipital carina variable 20

19. Posterior surface of propodeum with dense, appressed, brown hairs that narrowly border metapostnotum, punctures barely visible because of the hairs. T1 with yellow apical band, no bands on T2-T4. Wings evenly infuscated, forewing with clear subapical spot. Legs dark . . . . . *crassipes*

—. Posterior surface of propodeum with punctures that bear small hairs; punctures may or may not reach border of metapostnotum. T1-T4 with cream-colored apical bands, T5 with cream-colored lateral spots. Wings darkened on apical band. Legs reddish . . . . . *singularis*

20. Apex of S5 not bent down (lateral view, fig. 42), margin broadly convex. Mesepisternal band present. Length 9.0-12.5 mm 21

—. S5 bent down apically (lateral view, fig. 43), if not clearly so (*crinita*), mesepisternal band absent. Size variable 23

21. Paraocular area swollen between antennal socket and upper ocular third. Ocellocular area not depressed, frontal view as in fig. 39. Maximum width of hind basitarsus 1.66-1.82 times apical width. Wings darkened along costal margin . . . . . *crassicornis*

—. Paraocular area between antennal socket and upper ocular third not swollen. Ocellocular area depressed, (fig. 38). Hind basitarsus narrower, maximum width 1.30-1.50 times apical width. Wings darker apically 22

22. Apical band on T2 broadly interrupted medially, reduced to lateral spot . . . . . *simplicicornis*

—. Apical band on T2 complete . . . . . *similaris*

23. Mesepisternal band absent 24

—. Mesepisternal band present, at least from level of scrobe to base of middle coxa 25

24. Apical denticles of labrum on rim (fig. 17). Elevation between antennal sockets with sides slightly concave (cross-section fig. 41). S5 before apex gently convex, the sides not sharply curved upward . . . . . *crinita*

—. Apical denticles of labrum placed before rim (fig. 18). Elevation between antennal sockets with sides convex (cross-section fig. 40). S5 flat before bent apex, the sides sharply curved upward . . . . . *pilicornis*

25. Apical band on T2 broadly interrupted. Preoccipital carina complete, sharp all the way around, angle nearly absent. Body length 6-9 mm . . . . . *chacoensis*

—. Apical band on T2 complete. Preoccipital carina near angle indistinct or absent. 26

26. Body length 7-8 mm. Yellowish hairs around antennal sockets extended, reaching upper end of clypeus which is thoroughly covered by white pubescence . . . . . *burmeisteri*

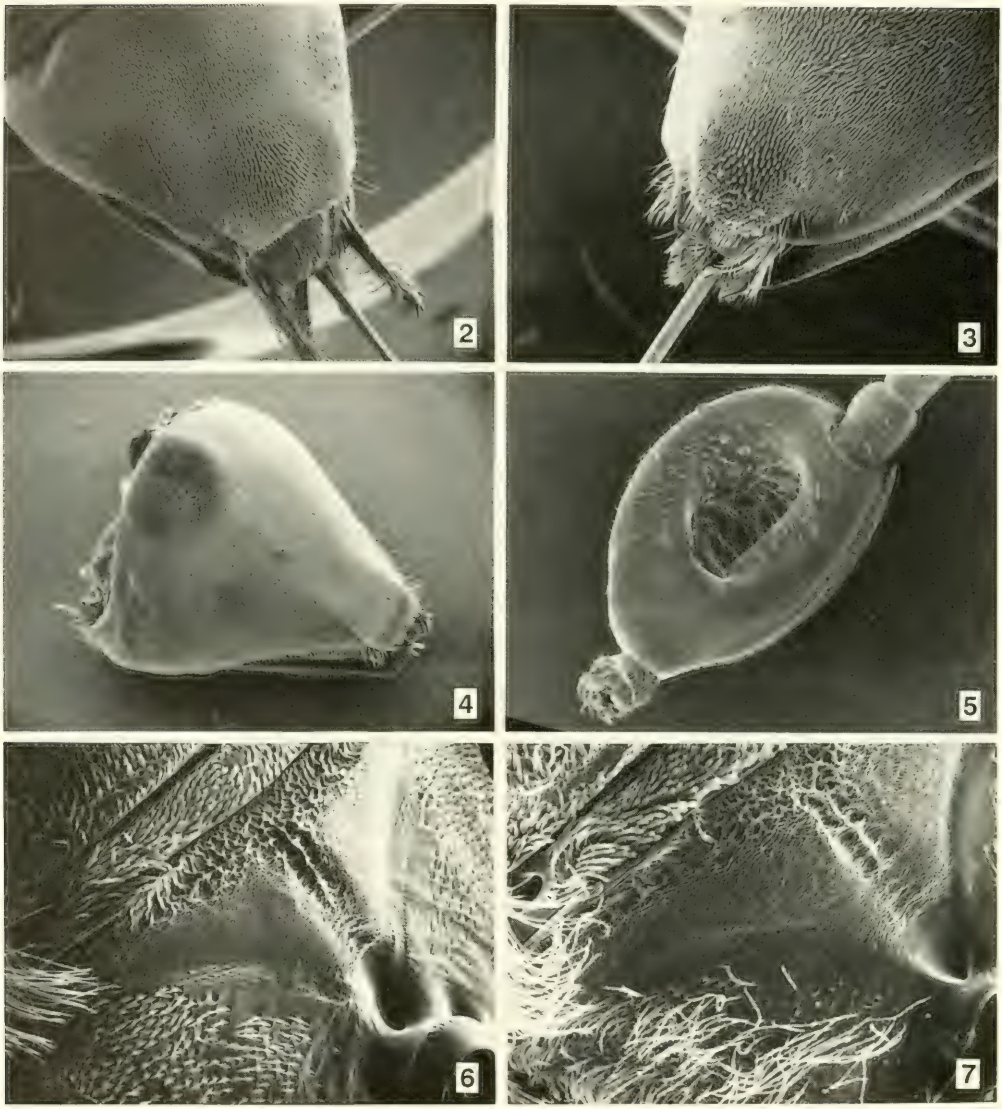
—. Body length 9-12 mm. Conspicuous yellowish hairs restricted to sides of antennal sockets; clypeus with dense white pubescence only on apical third . . . . . *holmbergi*

Males

1. Scape swollen, with conspicuous cavity 2

—. Scape not swollen 12

2. Posterior surface of propodeum at



FIGS. 2-7. 2, *Doeringiella singularis*, apex of female abdomen showing pseudopygidial area on T5. 3, *D. guttata*, same. 4, *D. centuncula*, same. 5, *D. bipunctata*, scape of male. 6, *D. singularis*, posterior view of thorax showing propodeum and metapostnotum. 7, *D. gayi*, same.

sides of metapostnotum with erect hairs (fig. 7) 3
—. Posterior surface of propodeum with hairs appressed, restricted to the posterolateral angles 11
3. Fringe of hairs on S5 medially reduced, less developed than on S4. (Hairy species with long, creamy-yellow hairs on most of head and thorax. T1 covered with creamy-yellow pubescence except a central transverse black area; T2-T6 with apical bands) . . . . . *gigas*
—. Fringe of hairs on S5 not medially reduced, similar to that on S4 4
4. Notaular spots elongate, well separated (fig. 9). Scape globose, as long as basal 5.5-6 flagellomeres together (fig. 46). Scutellum with middle longitudinal impression weak. (T1-T2 with apical bands) . . . . . *bizonata*
—. Notaular spots nearly confluent

on median scutal line, or complete anterior band present. Scape shorter, if nearly as long as combined length of basal 5 flagellomeres, middle longitudinal impression of scutellum strong 5

5. Axilla projected as strong tooth (figs. 30, 31, 35). Scape as long as basal 3.5-4.7 flagellomeres. Legs dark 6

—. Axilla short, triangular (fig. 36). Scape shorter than basal 3 flagellomeres. Legs mostly light red 9

6. Maculations white. Scutum with broad anterior band of short, appressed, silvery hairs. Metanotal tuft black. (Underside of flagellomeres brown) . . . . . *bipunctata*

—. Maculations yellowish. Notaular spots evident, in spite of extended pale pubescence in some cases. Metanotal tuft pale 7

7. T1 without pale apical band. Vertex moderately slanting behind ocelli; posterior ocelli separated from rear margin of head by a distance equal to maximum ocellar diameter. (Scape as in fig. 48). . . . . *paranensis*

—. T1 with pale apical band, sometimes interrupted medially. Vertex very short, steep behind ocelli; posterior ocelli separated from rear margin of head by a distance less than maximum ocellar diameter. 8

8. Metasomal pubescence other than bands mostly black. Scape as fig. 45 . . . . . *arechavaletai*

—. Metasomal pubescence other than bands whitish. Scape as fig. 49 . . . . . *cochabambina*

9. Scutellum red. Hairs on underside of middle femur shorter than apical femoral width. T1-T6 with apical bands. . . . . *centuncula*

—. Scutellum black. Hairs on underside of middle femur as long as or longer than apical femoral width. Apical bands only on T1-T2 10

10. Pubescence other than maculations black. Metanotal tuft black. T1 and T2 with broad white apical band. Whole antenna red . . . . . *baeri*

—. Pubescence other than maculations grayish. Metanotal tuft pale. T1 and T2 with narrow cream-colored apical band. Scape black . . . . . *coelicera*

11. T1 with subapical band narrowed medially or interrupted. Hole of scape round (fig. 51) . . . . . *indecissa*

—. T1 with apical band. Hole of scape kidney-shaped (fig. 53). . . . . *crassicornis*

12. Scutellum red. 13

—. Scutellum black 14

13. Clypeus and labrum red. Scutellum clothed with pale hairs. Posterior surface of propodeum evenly covered with dense appressed hairs . . . . . *guttata*

—. Clypeus and labrum black. Scutellum with black hairs arising from punctures. Posterior surface of propodeum at sides of metapostnotum bare, short hairs restricted to posterolateral angles . . . . . *speciosa*

14. Supraclypeal area flat, not protruding in front of eyes when seen laterally. Forewing with dark costal band, remainder of wings hyaline . . . . . *oblata*

—. Supraclypeal area protruding in front of eyes. Both wings dusky throughout or darker towards apices 15

15. Posterior surface of propodeum at sides of metapostnotum with erect, long hairs (fig. 7), sometimes restricted to the posterolateral angles 16

—. Propodeum with short, appressed hairs (fig. 6). 20

16. Hairs of fringe on S5 shorter than on S4, and straight. Posterior scutal, scutellar and metanotal bands present 17

—. Hairs of fringe on S5 as developed as that on S4, long and apically curled. Posterior scutal, scutellar and metanotal bands absent. 18

17. Apical band on T1 expanded laterally, leaving a central, semicircular black area; on T2 also expanded laterally. Tergal bands creamy-yellowish. Mesepisternal band complete, of long hairs. Flagellum

mostly reddish . . . . . *gayi*

—. Apical band on T1 of uniform width or slightly expanded laterally; on T2 transverse. Tergal bands whitish. Mesepisternal band reduced, of short hairs. First flagellomere reddish, rest of flagellum black . . . . . *tricolor*

18. Plical surface of scape evenly curved, without sub-basal angle (fig. 25). Long hairs on propodeum usually restricted to posterolateral angles. Apical tergal bands yellowish, narrow, or metasoma wholly black. (Erect hairs on plical surface as long or longer than apical width of scape, also erect hairs present on opposite surface). . . . . *jorgenseni*

—. Plical surface of scape with sub-basal angle. Posterior surface of propodeum with long hairs at sides of metapostnotum. T1 and T2 with broad white apical bands 19

19. Sub-basal angle of scape weak. Preoccipital carina complete. T5-T6 with apical band. Antenna mostly red . . . . . *potrerillensis*

—. Sub-basal angle of scape notably strong (fig. 24). Upper sector of preoccipital carina obliterated near angle. T5-T6 black. Antenna yellowish . . . . . *angulicornis*

20. Hind tibia notably swollen, thicker than femur (fig. 21). Propodeum posteriorly with dense, appressed, pale hairs that closely border metapostnotum. T1-T2 with apical band . . . . . *crassipes*

—. Hind tibia not thicker than femur. Posterior surface of propodeum at sides of metapostnotum usually bare and without punctures; if punctures and hairs present, then T1-T6 with apical bands 21

21. Plical surface of scape with erect hairs as long as width of pedicel. Mesepisternal band absent. Preoccipital carina complete 22

—. Plical surface of scape with hairs no longer than half diameter of pedicel. Mesepisternal band and preoccipital carina variable. 23

22. Plical surface of scape with sub-basal angle indistinct, opposite surface with hairs erect. Fringe on S5 as well developed as that on S4 . . . . *crinita*

—. Plical surface of scape with sub-basal angle strong, opposite surface with hairs mostly appressed. Fringe on S5 barely surpasses posterior margin of sternum . . . . . *pilicornis*

23. Posterior surface of propodeum at sides of metapostnotum with punctures that bear small hairs (fig. 6); punctures may or may not reach border of metapostnotum. Preoccipital carina complete. Fringe on S5 with hairs long, surpassing posterior border of sternum by 1/3 of their length. (Maculations white, legs red) . . . . . *singularis*

—. Posterior surface of propodeum at sides of metapostnotum bare, without punctures, hairs restricted to posterolateral angles; if punctures are more widespread on posterior surface of propodeum (some specimens of *cingillata*), upper sector of preoccipital carina weak near angle, and fringe on S5 with short, straight hairs, barely surpassing posterior border of sternum 24

24. T1 with extensive pale pubescence laterally and apically, with central oval area almost to completely devoid of pale hair. Fringe on S5 as developed as that on S4, hairs long and apically curled. . . . . *oblonga*

—. T1 with apical band. Fringe on S5 usually reduced, when more or less developed, size small, less than 8 mm long. 25

25. Underside of middle femur with appressed, sparse, very short hairs. Preoccipital carina complete. (Mesepisternal band present. Fringe on S5 barely surpasses posterior margin of sternum) . . . . . *chacoensis*

—. Underside of middle femur with erect, long hairs, at least as long as half apical width of femur. Preoccipital carina usually obliterated near angle 26

26. Maculations on thorax poorly defined. Wings ferrugineous. Some punctures extending onto posterior

surface of propodeum. Proportion of AOD to IAD 0.50-0.61 . . . . . *cingillata*

—. Maculations on thorax clearly defined. Wings hyaline or infuscated. Punctures and hairs restricted to posterolateral angles of propodeum. Proportion of AOD to IAD 0.35-0.46 27

27. Length less than 8 mm. Fringe on S5 surpassing posterior margin of sternum, hairs slightly curled. . . . . *burmeisteri*

—. Length more than 8 mm. Fringe on S5 reduced, especially in middle, barely surpassing posterior margin of sternum. 28

28. T2 with apical band broadly interrupted in middle, reduced to lateral spots. Notaular spots separated from posterior border of pronotum by a black to brown, transverse band . . . . . *simplicicornis*

—. T2 with apical band complete. Notaular spots reaching posterior border of pronotum or not 29

29. Thorax globose, its maximum width 1.15-1.20 times maximum width of head. Notaular spots usually separated from posterior border of pronotum by transverse, dark band. S2 with apical band of dense, semiappressed, white hairs . . . . *similaris*

—. Maximum width of thorax 1.0-1.06 times maximum width of head. Notaular spots reaching posterior border of pronotum. S2 with apical hairs not forming dense band . . . . . *holmbergi*

Doeringiella angulicornis sp. nov.
(Fig. 24)

This remarkable species is described from a single male. The shape of the scape is unique, with the sub-basal angle strongly developed (fig. 24), hence the specific name. The genitalia approach those of *baeri*, *coelicera* and *centuncula*, whose males have swollen scapes. The color pattern, deep black vestiture with white maculations, is similar to that of *baeri*, but the antennae, legs and venation are yellowish.

Holotype male. Length 11.0 mm, length of forewing 9.5 mm. (a) Integument black; center of mandible, labrum in part and pronotal lobe red; antenna and legs beyond coxae yellowish brown; metasomal sterna brown basally. Wings hyaline with dark apical band, veins yellowish brown. (b) Face and labrum with long, appressed hairs; scape with erect, white hairs, on plical surface as long as diameter of pedicel; a few white hairs on sternal region of thorax; remainder of head and thorax with long black vestiture, on scutum mixed with stiff, simple, black hairs; propodeum completely covered with long, erect, black hairs; hairs on legs mostly white, but on femora black hairs also present; pubescence of metasoma other than maculations black; sternal fringes black. (c) Maculations of short, appressed, white hairs; pronotal band complete, narrow centrally; scutum with broad anterior band; no other maculations on thorax; T1-T2 with broad apical bands. (d) Middle of mesepisternum with close, coarse punctures, diameter 0.04-0.06 mm, interspaces very narrow. (e) Upper sculptured band of metapostnotum narrower than metanotum; longitudinal impression distinct. Propodeum at sides of metapostnotum with dense punctures and hairs. (g) Paraocular area swollen between antennal socket and upper ocular third. (h) Frontal carina keeled, beginning immediately below anterior ocellus and reaching lower level of antennal sockets. (i) Paraocular carina reaching lower tangent of anterior ocellus. (j) Preoccipital carina obliterated near angle, poorly developed in general. (l) Labrum 0.64 times as long as wide; no upper tubercles; denticles separated by 0.17 times labral length; apical point present. (n) Longitudinal impression of scutellum weak; axilla triangular, tooth very short. (o) Supraspiracular carina restricted to top of spiracle. (s) Length of vein r 0.68 times base of second submarginal cell. (u) Proportion of LID to UID 0.80; AOD to IAD 0.36. (v) Scape not swollen, 0.40 times UID; subbasal angle notably strong; proportion of first and second flagellomeres together to scape 0.86. (w) Fringe on S5 with long hairs, apically curled, surpassing posterior margin of sternum. (x) Middle femur on underside with erect hairs shorter than apical width; hind femur also with long, erect hairs. (y) Basal third of dorsal edge of penis not sclerotized; without lamella. Volsella present, hairy.

Material studied. Holotype male, *ARGENTINA:* Jujuy: El Aguilar, 4500 m, 12-I-1972, D.J. Brothers (KU).

Doeringiella arechavaletai (Brèthes)
(Figs. 35, 45, 72)

Epeolus arechavaletai Brèthes, 1909: 69. Lectotype female, by present designation, no locality label, supposedly from Uruguay (MACN, examined).

Epeolus peterseni Jörgensen, 1912a: 139-140. Holotype male, by monotypy, from Argentina, San Luis, 22-XII-1908 (MLP, examined). Jörgensen, 1912b: 315. **Synon. nov.**
Doeringiella (Doeringiella) arechavaletai: Moure, 1954: 266.
Doeringiella (Doeringiella) peterseni: Moure, 1954: 266.

The lectotype bears a handwritten label of Brèthes "*Epeolus arechavaletai*" and a printed label "Col. J. Brèthes". A second specimen with the same labels, at present in Curitiba, is designated paralectotype. Brèthes stated that the specimens probably came from Uruguay; none has locality label.

This species, together with *paranensis*, is the largest in the genus. It belongs to the group with the female pseudopygidial area reduced and the male scape swollen. Among the four species in this group with the scutellum bigibbous and the axilla projected as a strong tooth, it can be distinguished by the deep black vestiture other than maculations and the shape of the scape in both sexes, in the female with plical surface concave apically.

Female. Length 12.3-15.5 mm (n = 10, m = 14.2, lectotype 14.7); length of forewing 9.7-12.2 mm (n = 10, m = 10.9, lectotype 11.2). (a) Integument deep black, only center of mandible red. (b) Hairs around antennal socket brown; head and thorax with erect, black hairs; hairs of metanotal tuft with pale tips; legs with black vestiture, except outer surface of hind coxa and tibia with white hairs; propodeum with long, erect, brown to black hairs; vestiture of metasoma other than maculations black. (c) Maculations of short, appressed, pale yellow hairs. Pronotal band poorly marked at sides; notaular spots poorly delimited, with some black intermixed hairs; posterior scutal band reduced to lateral spot or complete; no other maculations on thorax; T1-T3 in lectotype with apical band complete and T4 with apical band briefly interrupted medially, in other specimens all bands can be interrupted and on T3-T4 can be absent. (d) Thorax with coarse punctures, slightly separated, diameter 0.05-0.065 mm on middle of mesepisternum, smaller on scutum and scutellum. (e) Upper rugose band of metapostnotum as wide as metanotum; longitudinal impression present. Propodeum at sides of metapostnotum densely punctured, with long erect hairs. (f) Proportion of LID to UID 0.72-0.77 (n = 10, m = 0.74, lectotype 0.75); AOD to IAD 0.63-0.82 (n = 10, m = 0.70, lectotype 0.72). (g) Paraocular area swollen between antennal socket and upper ocular third. (h) Frontal carina keeled, beginning immediately below anterior ocellus, reaching lower level of antennal sockets and entering supraclypeal area as flat, shiny keel; elevation between sockets tuberculiform, with sides convex. (i) Paraocular carina ending below lower tangent of anterior ocellus. (j) Upper sector of preoccipital carina absent, area behind ocelli steep, with strong punctures. (l) Labrum 0.63-0.68 times as long as wide (n = 10, m = 0.66, lectotype 0.65); upper tubercles well developed, area between them depressed; apical denticles separated by 0.24-0.34 times labral length (n = 10, m = 0.28, lectotype 0.30); apical point and short apical longitudinal carina present. (m) Scape 0.42-0.46 times UID (n = 10, m = 0.44, lectotype 0.44); proportion of first and second flagellomeres together to scape 0.72-0.86 (n = 10, m = 0.77, lectotype 0.80); sub-basal angle strong; apical third of plical surface concave, delimited by longitudinal keel. (n) Scutellum bigibbous with strong longitudinal impression; axilla produced as strong tooth. (o) Supraspiracular carina well developed, continued along posterolateral angle of propodeum, ending in tubercle. (p) Apex of S5 not reflexed. (q) T5 without basal patch of hairs. Pseudopygidial area poorly defined, formed by thin hairs, 0.2 times as long as wide. (s) Length of vein r 0.9-1.1 times base of second submarginal cell.

Male. Length 13-17.5 mm (n = 5, m = 14.8); length of forewing 10.2-11.8 mm (n = 5, m = 11.0). (t) Vestiture similar to that of female, but white hairs covering whole face, more extended on legs, sternal region of thorax and propodeum in some specimens. Scutum with broad anterior band; posterior scutal band usually complete. Metasomal bands always present on T1-T4, variable on T5 and T6; bands complete or interrupted. (u) Proportion of LID to UID 0.76-0.77 (n = 5, m = 0.762); of AOD to IAD 0.37-0.48 (n = 5, m = 0.41). (v) Scape greatly swollen, 0.64-0.67 times UID (n = 5, m = 0.65); as long as basal 4.5-4.75 flagellomeres; proportion of first and second flagellomeres together to scape 0.44-0.54 (n = 5, m = 0.50); cavity wider than entrance hole. (w) Fringe on S5 with dense, long hairs that surpass posterior margin of sternum. (x) Underside of middle femur with erect hairs shorter than apical width; of hind femur with short semiappressed hairs. (y) Dorsal edges of penis parallel, continuously sclerotized, without lamella. Volsella indicated by faint sclerotization.

Material studied. ARGENTINA: SALTA: 1 F, Chorrillos, 2000 m, II-1987, M. Fritz (MF). CATAMARCA: 1 F, 1 M, Andalgalá, El Potrero, 10-III-1974, J.L. Neff, on *Verbena encelioides* (CTMI). MENDOZA: 1 M (CAS); 1 M, Tupungato, 1500 m, 25-I-1961, A. Willink (IML). SAN LUIS: 1 M, San Luis, 22-XII-1908 (holotype of *Epeolus peterseni*). BUENOS AIRES: 1 M, Sierra de la Ventana, I-1952, F.H. Walz (KU); 1 M, San Blas (MACN); 1 M, Mar del Plata, Farina (MACN); 3 F, 3 M, Felipe Sola, XII-1944, A. Martínez (MLP); 1 M, Felipe Sola, I-1959, Martínez (UFPR); 1 F, Bolívar, XI-1950, J. Foerster (KU); 1 F, Bolívar, XI-1951 (MLP). LA PAMPA: 2 F, 1 M, (MACN). RIO NEGRO: 1 F, Pomona,

XII-1984, M. Fritz (MF); 1 F, Lamarque, I-1974, M. Fritz (MF); 1 F, 1 M, Rio Colorado, 19-II-1913, P. Jörgensen (MLP); 1 F, Rio Colorado, XI-1953, F.H. Walz (UFPR). Neuquen: 1 F, Alicura, 9-II-1972, D.J. Brothers, D.C. Lloyd (KU).

Doeringiella baeri (Vachal)
(Figs. 16, 55, 59, 60, 67)

Epeolus baeri Vachal, 1904: 23-24. Lectotype female, by present designation, from Argentina, Tucumán, Lara, 4000 m, G.A. Baer (Mus. Paris examined). Schrottky, 1913: 264.
Doeringiella (Orfilana) baeri: Moure, 1954: 270.

This species can be recognized by the swollen male scape, the labrum with close apical denticles, the wholly red antenna, the contrasting black coloration with white maculations, female with well developed pseudopygidial area and S5 not bent down apically. Some specimens are more hirsute than others; specimens from Mendoza have hairs on the face mostly appressed. The anterior femur has long black hairs in the lectotype and specimens from El Infiernillo, El Cincel and Tin Tin.

Female. Length 8-10.5 mm (n = 5, m = 9.7, lectotype 10.5); length of forewing 6.6-9 mm (n = 5, m = 7.9, lectotype 8.5). (a) Integument black; mandible dark red; following parts light reddish: entire antenna, legs beyond coxae, pronotal lobe and tegula. Wings moderately to strongly infuscated, darker apically; stigma and veins of basal half of wing reddish. (b) Body hirsute, head and thorax with long, erect, black hairs; stiff, simple hairs among normal plumose ones; propodeum completely covered with long black hairs; femoral hairs vary from long and black to short and pale; vestiture of metasoma other than maculations black. (c) Maculations of short, appressed, white hairs (in lectotype yellowish, obviously dirty); pronotal band medially interrupted; notaular spots united, forming continuous transverse band; no other maculations on thorax; T1 and T2 with complete apical bands. (d) Middle of mesepisternum with coarse, confluent punctures, diameter 0.03-0.06 mm (lectotype 0.05-0.056), interspaces narrow. Scutum and scutellum also with strong confluent punctures, but smaller. (e) Metapostnotum with upper rugose band narrower than width of metanotum, with marked longitudinal impression. Propodeum around metapostnotum with strong punctures and long hairs. (f) Proportion of LID to UID 0.72-0.76 (n = 5, m = 0.73, lectotype 0.72); AOD to IAD 0.63-0.77 (n = 5, m = 0.70, lectotype 0.71). (g) Paraocular area not depressed, supra-antennal area moderately depressed. (h) Frontal carina keeled, low, beginning half ocellar diameter below anterior ocellus, barely surpassing lower level of sockets; elevation between antennal sockets with sides slightly concave. (i) Paraocular carina not reaching lower tangent of anterior ocellus. (j) Upper sector of preoccipital carina poorly marked near angle. (l) Labrum 0.56-0.64 times as long as wide (n = 5, m = 0.61, lectotype 0.61), slightly concave medially; no tubercles or longitudinal carina; denticles clearly preapical, separated by 0.12-0.185 times labral length (n = 5, m = 0.154, lectotype 0.185). (m) Scape short and thick, 0.31-0.36 times UID (n = 5, m = 0.32, lectotype 0.31); proportion of first and second flagellomeres together to scape 1.06-1.22 (n = 5, m = 1.14, lectotype 1.22); subbasal angle slightly marked. (n) Upper surface of scutellum without longitudinal impression; axilla short, triangular, scarcely projecting. (o) Supraspiracular carina short, concave, restricted to top of spiracle. (p) Apex of S5 not bent down. (q) Base of T5 with hairs dense, but not a distinct patch. Pseudopygidial area 0.75 as long as wide, semicircular. (s) Length of vein r 0.65-0.85 times base of second submarginal cell.

Male. Length 8-12 mm (n = 3, m = 10); length of forewing 7.3-8.8 mm (n = 3, m = 8.2). (t) Vestiture similar to that of female, face with silvery hairs, anterior band on scutum wider; venter of thorax with white hairs; sternal fringes black. (u) Proportion of LID to UID 0.77-0.84 (n = 3, m = 0.79); of AOD to IAD 0.42-0.45 (n = 3, m = 0.45). (v) Scape swollen, 0.50-0.52 times UID (n = 3, m = 0.51), as long as basal 3 flagellomeres together; proportion of first and second flagellomeres together to scape 0.72-0.74 (n = 3, m = 0.73); cavity wider than entrance hole. (w) Fringe on S5 with curled hairs that surpass posterior margin of sternum. (x) Underside of middle femur with erect hairs as long as apical width. (y) Basal third of dorsal edges of penis not sclerotized; no lamella. Volsella present, hairy.

Material studied. *ARGENTINA:* Jujuy: 1 F, Rio Cincel, W of Abra Pampa, 3500-3700 m, II-10-1970, L. Peña (AMNH). Salta: 3 F, Yacochuya, NW Cafayate, 1950 m, 1-15-II-1969, Malaise trap, Willink, Terán, Stange (IML); 3 F, 1 M, Alturas Amblayo, 3200 m, XII-1986, M. Fritz (MF); 1 F, Recta de Tin Tin, Agua del Guanaco, 3600 m, I-1987, M. Fritz (MF). Tucuman: 1 F, lectotype, Lara, 4000m, G. A. Baer (Paris); 1 F, El Infiernillo, 3000 m, 3-I-1974, A. Willink (IML); 1 F, Tafí del Valle, 2100 m, 2-3-XII-1979, C. M. Vardy (BMNH). Catamarca: 1 F, Minas Capillitas, 3000 m, 3-I-1973, J. L. Neff, on *Senecio flagellisectis* (CTMI); 1 M, El Pucará, 2000 m, 22-XI-1972, J. L. Neff, on *Glandularia* (CTMI); 1 M, Cuesta Minas Capillitas, 3000 m, 27-I-1974, J. L. Neff (CTMI). Córdoba: 1 F, Saltos Blancos, 7-I-1980, L. Stange, R. Woodruff (FSCA). Mendoza: 4 F, Uspallata, XII-1979, A. Roig A. (MACN, KU); 5 F, Uspallata, 1940 m, 6-XII-1979, C. and M. Vardy (BMNH).

Doeringiella bipunctata (Friese)
(Figs. 5, 10, 14, 30, 52)

Epeolus bipunctatus Friese, 1908: 83. Lectotype female, by present designation, from Argentina, Salta, 1200 m, 20-XII-1905, Steinbach col. (ZMB, examined). Jensen-Haarup, 1908: 106; Jörgensen, 1909: 218-219; Jörgensen, 1912a: 139; Jörgensen, 1912b: 315; Friese, 1912: 364; Schrottky, 1913: 264.
Doeringiella (Doeringiella) bipunctata: Moure, 1954: 265.

This species is easy to recognize among related forms with the female pseudopygidial area reduced and the male scape swollen by its extensive black coloration, the silvery maculations of male, the low proportion of AOD to IAD and the weak longitudinal impression of the scutellum. The presence of stiff hairs on the male sternum 8 is an autapomorphy.

Female. Length 10.2-13.8 mm (n = 5, m = 11.5, lectotype 12); length of forewing 9-11 mm (n = 5, m = 9.9, lectotype 11). (a) Integument black. Forewing deeply infuscated, hindwing infuscated on apical third. (b) Entire body covered with black hairs. (c) Maculations reduced to white lateral spot on T1 and white strip on hind coxa. (d) Middle of mesepisternum with dense, close punctures, diameter 0.025-0.031 mm, interspaces narrow, polished; punctures on scutum smaller, more separated. (e) Upper rugose band of metapostnotum narrower than width of metanotum, longitudinal impression weak. Propodeum at sides of metapostnotum densely punctured, with long, erect hairs. (f) Proportion of LID to UID 0.67-0.71 (n = 5, m = 0.69, lectotype 0.70); AOD to IAD 0.55-0.62 (n = 5, m = 0.59, lectotype 0.60). (g) Supra-antennal area well depressed. Paraocular area swollen between antennal socket and upper ocular third. (h) Frontal carina keeled, beginning half ocellar diameter below anterior ocellus, briefly surpassing lower level of sockets; elevation between antennal sockets with sides slightly convex. (i) Paraocular carina ending just below lower tangent of anterior ocellus. (j) Preoccipital carina complete, sharp; angle low. (l) Labrum 0.61-0.72 times as long as wide (n = 5, m = 0.66, lectotype 0.72), with a shallow central depression; no upper tubercles; apical denticles separated by 0.21-0.28 times labral length (n = 5, m = 0.23, lectotype 0.21); no apical point nor longitudinal carina. (m) Scape 0.43-0.45 times UID (n = 5, m = 0.44, lectotype 0.43), proportion of first and second flagellomeres together to scape 0.84-0.91 (n = 5, m = 0.87, lectotype 0.91); plical surface concave apically, subbasal angle present. (n) Longitudinal impression of scutellum weak; axilla produced in long, strong, inwardly bent tooth. (o) Supraspiracular carina strong above spiracle. (p) Apex of S5 not bent down. (q) T5 without basal patch of hairs. Pseudopygidial area poorly defined, of thin hairs, 0.2 times as long as apical width. (s) Length of vein r 0.85-1.0 times base of second submarginal cell.

Male. Length 10.2-13.5 mm (n = 8, m = 11.7); length of forewing 8.8-10.7 (n = 8, m = 9.8). (t) Male differs in appearance from female due to silvery white maculations: whole face up to anterior ocellus; convex surface of scape; pronotal band interrupted medially, but covering whole pronotal lobe; broad medially interrupted band on anterior third of scutum; posterior scutal band as lateral spot; tegula (basal third and apex); central spot on scutellum; mesepisternum in some specimens with spot below pronotal lobe; hind coxa above; T1 with apical band briefly interrupted, T2 with apical band broadly interrupted, on T3-T6 lateral spots may be present, variable. Flagellum with longitudinal light brown stripe. Wings hyaline with dark apical band. (u) Proportion of LID to UID 0.71-0.77 (n = 5, m = 0.74); AOD to IAD 0.37-0.44 (n = 5, m = 0.41). (v) Scape greatly swollen, 0.60-0.65 times UID (n = 5, m = 0.63), as long as the 4 basal flagellomeres together; proportion of first and second flagellomeres together to scape 0.53-0.56 (n = 5, m = 0.55); cavity present; entrance hole ample, but narrower than cavity. (w) Fringe on S5 with curled apical hairs that surpass posterior margin of sternum. (x) Underside of middle femur with erect hairs as long as apical width; hind femur with short semiappressed hairs. (y) Dorsal edges of penis continuously sclerotized, parallel, without lamella. Volsella indicated by faint sclerotization.

Material studied. 41 F and 38 M from *URUGUAY:* Montevideo, and *ARGENTINA:* provinces of Salta, Catamarca, La Rioja, San Juan, Mendoza, Buenos Aires, Rio Negro, Neuquén and Chubut (fig. 10). Collection dates are from September to early March. Flower record: *Grindelia* sp.

Doeringiella bizonata Holmberg
(Figs. 8, 9, 10, 12, 26, 46, 68, 73)

Doeringiella bizonata Holmberg, 1886a: 153-154, figs. 12-18. Lectotype female, by present designation, 10-II-1883 (MACN, examined). Holmberg, 1886b: 278; Dalla Torre, 1896: 335; Schrottky, 1903: 183; Cockerell, 1922: 10.
Epeolus bizonatus: Schrottky, 1913: 264.
Epeolus (Doeringiella) bizonatus: Cockerell, 1917: 479.
Doeringiella (Doeringiella) bizonata: Moure, 1954: 264, fig. a-e.

Three females and one male with Holmberg's handwritten labels are preserved in the MACN. One female in good condition is designated lectotype; the other 3 specimens are in poor condition. None has a locality label, but date labels (10-II-1883 and 25-II-1880) indicate that they belong to the original series.

Fig. 8. Lateral view of male *Doeringiella bizonata*.

This species is readily distinguished by its flat clypeus and supraclypeal area, reduced pseudopygidial area in the female and extraordinarily swollen scape in the male, as long as the basal 5.5-6 flagellomeres. The notaular spots are longer than wide, separated by a distance similar to the spot width; *bizonata* and *hebes* are the only species with this pattern.

Female. Length 10.2-15 mm (n = 22, m = 11.9); length of forewing 8.3-11 mm (n = 22, m = 9.5). (a) Integument black; center of mandible and tegula red; scape, pedicel and legs beyond coxae dark red; sterna and T6 may be reddish; first flagellomere usually reddish. Wings hyaline with broad, dark apical band, veins dark brown. (b) Hairs around antennal socket pale brown; supraantennal area, vertex and occipital region with erect brown hairs; clypeus, labrum, legs, thorax and metasoma excluding maculations with short, appressed, white to grayish hairs. Metanotal tuft pale. Propodeum with long, erect, white hairs. (c) Maculations of short, appressed, yellow hairs. Pronotal band complete; notaular spots elongated, separated; posterior scutal band complete, extended anteriorly; scutellar and metanotal bands interrupted medially, mesepisternal band from scrobe to base of middle coxa; vertical patch below pronotal lobe; T1-T2 with apical bands, some specimens with band on T2 briefly interrupted medially. (d) Middle of mesepisternum with rather coarse punctures, diameter 0.035-0.050 mm, interspaces narrow, shiny. (e) Upper band of metapostnotum wider than metanotum; longitudinal impression present. Propodeum at sides of metapostnotum with dense punctures and hairs. (f) Proportion of LID to UID 0.69-0.74 (n = 22, m = 0.72); AOD to IAD 0.62-0.73 (n = 22, m = 0.67). (g) Paraocular area swollen between antennal socket and upper ocular third. (h) Frontal carina keeled, beginning half ocellar diameter below anterior ocellus, reaching supraclypeal area as flat and shiny car-

ina; elevation between antennal sockets tuberculiform with sides convex. (i) Paraocular carina reaching lower tangent of anterior ocellus. (j) Upper sector of preoccipital carina distinct only behind ocelli, absent near angle. (k) Clypeus and supraclypeal area flat, as seen laterally scarcely protruding in front of eyes. (l) Labrum 0.56-0.64 times as long as wide (n = 22, m = 0.60); upper tubercles present, low, surface between them depressed; apical denticles separated by 0.30-0.36 times labral length (n = 22, m = 0.32); longitudinal carina and apical point present. (m) Scape 0.40-0.45 times UID (n = 22, m = 0.42), with longitudinal keel limiting plical surface, apical third concave, sub-basal angle strong; proportion of first and second flagellomeres together to scape 0.73-0.83 (n = 22, m = 0.77). (n) Longitudinal impression of scutellum weak; axilla triangular, produced as moderate tooth. (o) Supraspiracular carina strong, continued along postero-lateral angle of propodeum. (p) Apex of S5 not bent down. (q) T5 without basal patch of hairs. Pseudopygidial area poorly defined, 0.2-0.3 times as long as apical width, hairs slender. (s) Length of vein r 0.75-0.90 times base of second submarginal cell.

Male. Length 9.5-15.0 mm (n = 9, m = 12.1); length of forewing 8.4-11.6 mm (n = 9, m = 9.8). (t) Color and vestiture similar to those of female but hairs on face white, erect hairs on vertex pale, white hairs on convex surface of scape, sternal fringes brown. (u) Proportion of LID to UID 0.73-0.79 (n = 8, m = 0.76); AOD to IAD 0.30-0.39 (n = 8, m = 0.36). (v) Scape greatly swollen, 0.66-0.71 times UID (n = 8, m = 0.68), as long as basal 5.5-6 flagellomeres together; proportion of first and second flagellomeres together to scape 0.36-0.43 (n = 8, m = 0.39); cavity wider than entrance hole. (w) Fringe on S5 with curled hairs that surpass posterior margin of sternum. (x) Underside of middle femur with erect hairs shorter than apical width; hind femur with short appressed hairs. (y) Dorsal edges of penis parallel, continuously sclerotized, without lamella. Volsella indicated by faint sclerotization.

Material studied. 52 F and 173 M from *BRAZIL:* state of São Paulo, and *ARGENTINA:* provinces of Jujuy, Formosa, Santa Fe, Entre Rios, Córdoba, Buenos Aires, La Pampa, Rio Negro and Neuquén (Fig. 10). Collection dates are from mid September to early April.

Doeringiella burmeisteri (Friese)
(Fig. 65)

Epeolus burmeisteri Friese, 1908: 86-87. Lectotype male, by present designation, from Argentina, Mendoza, 10-I-1907 (ZMB, examined). Jensen-Haarup, 1908: 98, 107; Jörgensen, 1909: 220, 1912a: 142, 1912b: 316; Schrottky, 1913: 264.
Doeringiella (Orfilana) burmeisteri: Moure, 1954: 269-270.

This species belongs in a group characterized by the presence of a lamella with a conspicuous projection on the male penis, S5 of the female

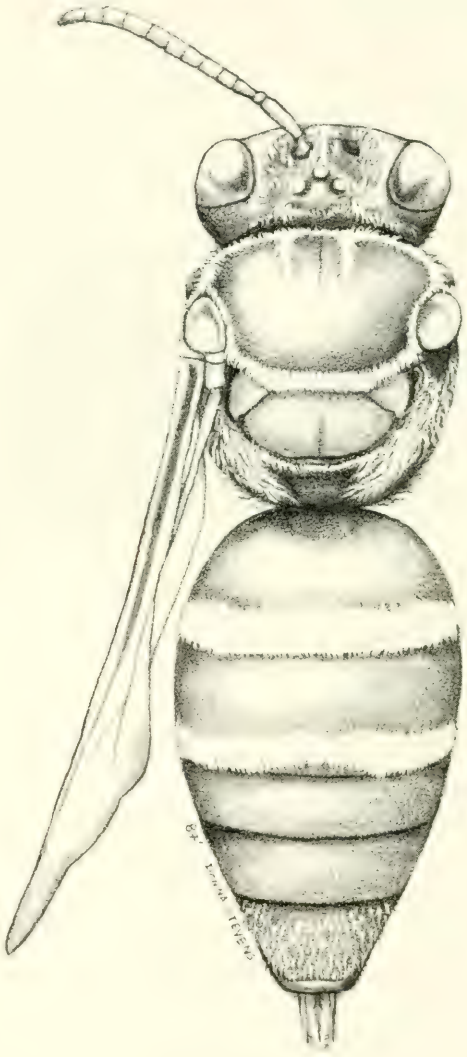


FIG. 9. Dorsal view of female *Doeringiella bizonata*.

with the apex clearly bent down and T5 with hairs denser on a central basal area, but not forming a distinctive patch. All are medium to small-sized species. Among them *burmeisteri* can be recognized by its longer scape (first and second flagellomeres together to scape 0.9-0.95), small size and color pattern; females can be confused with *chacoensis* (see comments under this species).

I have seen several specimens from Mendoza that seemingly belong to the original series (see *Material studied*); only the specimens designated lectotype and paralectotype bear Friese's identification labels. The lectotype bears a red "typus" label above my lectotype label.

Female. Length 6.7-8.2 mm (n = 5, m = 7.4);

Fig. 10. Distributions of *Doeringiella bizonata* (dots) and *D. bipunctata* (triangles).

length of forewing 5.0-5.7 mm (n = 5, m = 5.3). (a) Integument black; first flagellomere, pronotal lobe, tegula and legs beyond coxae light red; mandible, scape and pedicel reddish, partly darkened; specimens from Entre Rios have trochanters and femora darkened. Wings hyaline with dark apical band. (b) Hairs around antennal socket yellow; erect brown hairs on vertex and occipital region; clypeus, labrum, legs and postero-lateral angles of propodeum with white, appressed hairs; thorax and metasomal sterna with pubescence other than maculations very short, white to grayish, on metasomal terga brown. (c) Maculations of short, appressed, yellow hairs; pronotal band interrupted medially, paler on pronotal lobe; notaular spots round, contiguous; posterior scutal, scutellar and metanotal bands complete, narrow; mesepisternal band paler, whitish (complete in specimens from type locality, in specimens from Entre Rios beginning below scrobe); T1-T2 with apical bands, T3-T4 also with apical bands but less defined and paler, T5 with white pubescence denser at sides. (d) Middle of mesepisternum with punctures 0.025-0.035 mm in diameter, interspaces 1/4 to 1/5 of diameter of punctures; on scutum closer and smaller. (e) Upper rugose band of metapostnotum as wide as metanotum, with fine sculpture. Propodeum at sides of metapostnotum bare, shiny. (f) Proportion of LID to UID 0.72-0.76 (n = 5, m = 0.74); AOD to IAD 0.64-0.71 (n = 5, m = 0.67). (g) Depression of supra-antennal area shallow, more like that of *Triepeolus* than of other *Doeringiella* species. (h) Frontal carina beginning one ocellar diameter below anterior ocellus, reaching lower level of antennal sockets; elevation between sockets with sides straight. (i) Paraocular carina ending below lower tangent of anterior ocellus. (j) Preoccipital carina obliterated near angle. (l) Labrum 0.55-0.61 times as long as wide (n = 5, m = 0.57); apical denticles separated by 0.29-0.37 times labral length (n = 5, m = 0.33); upper tubercles weak, apical point present. (m) Scape 0.36-0.40 times UID (n = 5, m = 0.37); proportion of first and second flagellomeres together to scape 0.90- 0.95 (n = 5, m = 0.94); sub-basal angle weak, apical third of plical surface convex. (n) Longitudinal impression of scutellum weak, axilla triangular, produced as short tooth. (o) Supraspiracular carina small, restricted to top of spiracle. (p) Apex of S5 bent down. (q) T5 with short hairs denser on basal central area. Pseudopygidial area 0.75 as long as apical width. (s) Length of vein r 0.73-0.75 base of second submarginal cell.

Male. Length 6.9-8.0 mm (n = 7, m = 7.4, lectotype 6.9); length of forewing 4.8-5.6 mm (n = 7, m = 5.1, lectotype 5.0). (t) Vestiture and coloration similar to those of female but long white hairs over whole face and sternal region of thorax; pubescence other than maculations on thorax and legs longer than in female; T1-T6 with complete apical bands; sternal fringes white. (u) Proportion of LID to UID 0.76-0.82 (n = 7, m = 0.77, lectotype 0.77); AOD to IAD 0.41-0.46 (n = 7, m = 0.45, lectotype 0.46). (v) Scape not swollen, similar to that of female; 0.40-0.45 times UID (n = 7, m = 0.42, lectotype 0.43); proportion of first and second flagellomeres to scape 0.79-0.87 (n = 7, m = 0.84, lectotype 0.83). (w) Fringe on S5 with hairs slightly curved or straight, surpassing posterior margin of sternum. (x) Middle femur with erect hairs on underside longer than apical width; hind femur with appressed hairs on basal half. (y) Basal half of penis only partly sclerotized dorsally, lamella present, forming projection. Volsella present, hairy.

Material studied. ARGENTINA: Mendoza: 1 M lectotype, 10-I-1907 (ZMB); 1 F paralectotype, I-1907 (AMNH); 1 F, 1 M, 12-I-1907 and 10-I-1907 (MLP); 1 M, I-1907 (Museu São Paulo); 1 F, Chacras de Coria, Jensen-Haarup (MACN). La Rioja: 1 M, La Rioja (MACN). Entre Rios: 3 M, Primero de Mayo, II-1955, M. Fritz (UFPR); 1 F, V-1956, M. Fritz (UFPR); 1 F, Pronunciamiento, III-1973, M. Fritz (KU); 1 F, Arroyo Urquiza, III-1973, M. Fritz (MF).

Doeringiella centuncula sp. nov.
(Figs. 4, 36, 44, 50)

This species together with *hebes* is readily recognized by the lack of the upper sector of the preoccipital carina, the high proportion of IAD to AOD, the female pseudopygidial area parallel-sided, formed by slender and dense hairs (fig. 4), the conspicuous patch of hairs on the base of T5, and S5 narrowed apically with the apex bent down. It is distinguished from *hebes* by its axilla (projected as a short tooth) and T1 (with apical band). It is the only species that combines males with swollen scapes and red scutellum in both sexes. The specific name refers to the basal patch of hairs on the female T5.

Female. Length 8.4-9.6 mm (n=4, m=9.0, holotype 8.4); length of forewing 7.6-8.0 mm (n=4, m=7.8, holotype 7.6). (a) Integument black except following red: base of labrum, base of mandible, scape, pedicel, first flagellomere and base of second, round scutal spot contiguous with base of tegula, axilla in part, scutellum, central part of metanotum, trochanters in part, anterior femur, middle and hind femora except black underside, tibiae and tarsi. Wings with dark apical band, veins dark brown. (b) Hairs around antennal socket appressed, whitish; rest of head and thorax with short, whitish, sparse hairs mixed with long, erect ones; metanotal tuft pale; propodeum completely covered with dense, whitish hairs; legs with short, white hairs; metasoma with pubescence other than maculations gray. (c) Maculations whitish, of short, appressed hairs; pronotal band interrupted medially, not covering pronotal lobe; notaular spot small, triangular; posterior scutal band reduced to lateral spot; no other maculations on thorax; T1 with apical band, T2-T4 with apical bands interrupted medially. (d) Thorax with coarse punctation, middle of mesepisternum with punctures 0.035-0.05 mm in diameter, interspaces narrow, shiny. (e) Upper rugose band of metapostnotum wider than metanotum, longitudinal impression present. Propodeum at sides of metapostnotum with dense punctures and hairs. (f) Proportion of LID to UID 0.75-0.81 (n=4, m=0.77, holotype 0.75); AOD to IAD 0.74-0.77 (n=4, m=0.75, holotype 0.77). (g) Supra-antennal area slightly depressed, ocellocular area flat. (h) Frontal carina keeled, low, beginning immediately below anterior ocellus and reaching lower level of sockets; elevation between antennal sockets with sides straight. (i) Paraocular carina ending below lower tangent of anterior ocellus. (j) Upper sector of preoccipital carina obliterated. (l) Labrum 0.57-0.65 times as long as wide (n=4, m=0.61, holotype 0.57); no upper tubercles, longitudinal carina and small apical point present; apical denticles separted by 0.36-0.42 times labral length (n=4, m=0.38, holotype 0.37). (m) Scape 0.39-0.41 times UID (n=4, m=0,40, holotype 0.39); proportion of first and second flagellomeres together to scape 0.90-1.0 (n=4, m=0.96, holotype 0.96); sub-basal angle slightly marked. (n) Longitudinal impression of scutellum weak; axilla short, triangular, scarcely projecting. (o) Supraspiracular carina low, weakly developed in the holotype, in some specimes absent. (p) Apex of S5 narrow, bent down. (q) Base of T5 with outstanding patch of dense hairs. Pseudopygidial area nearly as long as apical width, parallel sided, of slender hairs. (s) Length of vein r 0.60-0.75 times base of second submarginal cell.

Male. Length 9.0-9.8 mm (n=2); length of forewing 7.8-8.5 mm. (t) Color and vestiture similar to those of female but scape black, face and venter of thorax with long, white hairs, bands on T1-T2 complete, on T3-T6 interrupted in middle, sternal fringes pale. (u) Proportion of LID to UID 0.78-0.79; AOD to IAD 0.48-0.50. (v) Scape swollen, 0.54-0.56 times UID; as long as basal 3-3.25 flagellomeres together; proportion of first and second flagellomeres together to scape 0.67-0.68; cavity wider than entrance hole. (w) Fringe on S5 with curled hairs that surpass posterior margin of sternum. (x) Middle femur with erect hairs on underside shorter than apical width; hind femur with very short, appressed hairs on basal two thirds. (y) Basal third of dorsal edges of penis not sclerotized; no lamella. Volsella present, hairy.

Material studied. *ARGENTINA:* JUJUY: 1 F holotype, Uquía, Quebrada de Humahuaca, 2800 m, 17-III-1978, Willink and Fidalgo (IML); 1 M paratype, same locality and collectors, 15-III-1978 (IML); 1 M paratype, 6 km S Volcán, 19-III-1967, Stange and Willink (MACN). SALTA: 14 F paratypes, El Alisal, III-1988, M. Fritz (MF, KU, MACN). CATAMARCA: 1 F paratype, Aimogasta, XI-4- 1972, G.E. Bohart (Utah). *BOLIVIA:* 2 F paratypes, Morochala, 2900 m (MLP).

Doeringiella chacoensis sp. nov.

This species resembles *burmeisteri* in coloration and size; these two forms are smaller than all others in the genus. *D. chacoensis* can be distinguished by the broadly interrupted band of T2 (both sexes), the tuberculiform elevation between the antennal sockets of the female, the high proportion of first and second flagellomeres together to the scape (1.04-1.09), and the complete preoccipital carina. This is the only *Doeringiella* whose males have short, appressed hairs on the underside of the middle femur. The name is from the biogeographic area where the species occurs.

Female. Length 5.7-9.0 mm (n=4, m=7.6, holotype 8.7); length of forewing 5.3-6.8 mm (n=4, m=6.0, holotype 6.4). (a) Integument black, the following light red: base of mandible, labrum, first flagellomere and base of second, pronotal lobe and tegula; scape, pedicel and legs reddish to nearly black. Wings infuscated, with dark apical band. (b-e) As in *burmeisteri*, but notaular spots small, transverse; mesepisternal band interrupted behind level of pronotal lobe; apical band on T2 broadly interrupted medially; T5 without denser hairs at sides. (f) Proportion of LID to UID 0.67-0.71 (n=4, m=0.70, holotype 0.71); AOD to IAD 0.67-0.73 (n=4, m=0.69,

holotype 0.73). (g) Paraocular and supra-antennal areas forming a continuous moderate depression. (h) Frontal carina beginning immediately below anterior ocellus, surpassing lower level of antennal sockets, ending in small shiny spot; elevation between sockets with sides convex. (i) Paraocular carina ending at level of lower tangent of anterior ocellus. (j) Preoccipital carina complete. (l) Labrum 0.57-0.65 times as long as wide (n = 4, m = 0.60, holotype 0.57); no upper tubercles; apical denticles separated by 0.29-0.34 times labral length (n = 4, m = 0.31, holotype 0.32); apical point present. (m) Scape 0.33-0.36 time UID (n = 4, m = 0.35, holotype 0.33); proportion of first and second flagellomeres together to scape 1.04-1.09 (n = 4, m = 1.06, holotype 1.09); sub-basal angle weak, section of plical surface on apical third convex. (n-q) As in *burmeisteri*, but pseudopygidial area 0.8-1.0 times as long as apical width, trapezoidal. (s) Length of vein r 0.6-0.8 times base of second submarginal cell.

Male. Length 7.7-9.0 mm (n = 2); length of forewing 6.2-6.3 mm. (t) Color and vestiture similar to those of female, but hairs on face and venter of thorax white; T3-T6 with apical bands that may be interrupted medially. (u) Proportion of LID to UID 0.74-0.75; AOD to IAD 0.44-0.47. (v) Scape not swollen, similar to that of female, 0.39-0.40 times UID; proportion of first and second flagellomeres together to scape 0.87-0.91. (w) Fringe on S5 of straight hairs that barely surpass posterior margin of sternum. (x) Middle femur with short, appressed hairs on underside similar to those on tibia; hind femur with short, appressed hairs on basal 1/5. (y) Basal half of penis only partly sclerotized dorsally, lamella present. Volsella present, hairy.

Material studied. Holotype female, *ARGENTINA:* Tucuman: Los Puestos, Depto. Leales, 11-IV-1967, A. Willink (IML). Paratypes: *ARGENTINA:* Salta: 1 F, La Viña, II-1985, M. Fritz (MF); 1 M, Pulares, 17-I-1973, J.L. Neff (CTMI). Tucuman: 1 M, same data as holotype, on *Mikania cordifolia* (IML); 1 M, Las Cejas, 2-IV-1966, L.A. Stange (UCD). *BOLIVIA:* Tarija: 1 F, Sachapera, 19-I-1950, A. Martínez (MLP). *PARAGUAY:* 1 F, Chaco, Cerro León, X-1979, M. Fritz (MACN).

Doeringiella cingillata Moure

Doeringiella (Orfilana) cingillata Moure, 1954: 275-277. Syntypes of both sexes from Curitiba and Nova Teutonia, Brazil (UFPR, examined).

This species is related to *burmeisteri* by the male penis with a lamella forming a projection. It is easily recognized by its reduced thoracic maculations (usually only the pronotal band and the notaular spots are present), the posterior surface of the propodeum with a few scattered punctures bearing small hairs, the lower sector of the female frontal carina blunt and the preoccipital carina absent near the angle. For a thorough account of this species, Moure's description should be consulted.

Female. Length 7.0-10.1 mm (n = 8, m = 8.4); length of forewing 5.8-7.5 mm (n = 8, m = 6.6). (a) Integument black; scape, pedicel, pronotal lobe and tegula brownish, in some specimens legs also brownish; center of mandible and first flagellomere reddish. Wings ferrugineous, apically darkened. (b) Face, labrum and legs with whitish hairs; vertex and occipital region with erect, brown hairs; most of thorax and metasoma with short pubescence varying from brown to grayish; metanotal tuft variable, brown to pale. (c) Maculations on thorax reduced to narrow, medially interrupted pronotal band of pale hairs; some specimens with posterior scutal and scutellar bands incipient laterally; T1-T4 with yellow apical bands. (d) Middle of mesepisternum with close, even punctures, diameter 0.025-0.035 mm, interspaces narrow, shiny; punctures on scutum smaller. (e) Upper rugose band of metapostnotum narrower than metanotum; longitudinal impression weak. Propodeum at sides of metapostnotum with scattered punctures bearing small hairs. (f) Proportion of LID to UID 0.72-0.77 (n = 6, m = 0.74); AOD to IAD 0.69-0.80 (n = 6, m = 0.75). (g) Paraocular area between antennal socket and upper ocular third moderately swollen. (h) Frontal carina beginning half ocellar diameter below anterior ocellus, briefly surpassing lower level of antennal sockets, lower sector blunt; elevation between sockets tuberculiform, with sides convex. (i) Paraocular carina reaching lower tangent of anterior ocellus. (j) Preoccipital carina obliterated near angle. (l) Labrum 0.54-0.60 times as long as wide (n = 6, m = 0.58); apical denticles preapical, separated by 0.24-0.33 times labral length (n = 6, m = 0.28); no longitudinal carina nor apical point. (m) Scape 0.33-0.39 times UID (n = 6, m = 0.36); proportion of first and second flagellomeres together to scape 0.92-1.08 (n = 6, m = 1.01); sub-basal angle weak; apical third of plical surface not concave. (n) Longitudinal impression of scutellum weak; axilla triangular, produced as short tooth. (o) Supraspiracular carina restricted to top of spiracle. (p) Apex of S5 bent down. (q) T5 with short hairs denser on basal central area, but not forming definite patch. Pseudopygidial area 0.7-0.8 times as long as apical width. (s) Length of vein r 0.62-0.78 times base of second submarginal cell.

Male. Length 7.8-12.0 mm (n = 5, m = 9.2); length of forewing 6.2-7.9 mm (n = 5, m = 7.1).

(t) Color and vestiture similar to those of female, but face with silvery hairs, venter of thorax with white hairs, notaular spots present, T1-T6 with yellow apical bands; sternal fringes pale. (u) Proportion of LID to UID 0.77-0.83 (n = 5, m = 0.80); AOD to IAD 0.50-0.61 (n = 5, m = 0.55). (v) Scape not swollen, similar to that of female; 0.41-0.44 times UID (n = 5, m = 0.43); proportion of first and second flagellomeres together to scape 0.80-0.86 (n = 5, m = 84). (w) Fringe on S5 with hairs short and straight, barely surpassing posterior margin of sternum. (x) Middle femur with erect hairs on underside shorter than apical width; hind femur with punctures and appressed hairs on basal 1/5 to 1/3. (y) Basal half of penis only partly sclerotized dorsally; lamella present, forming projection. Volsella present, hairy.

Material studied. ARGENTINA: CORRIENTES: 1 F, Ytuzaingó, IX-1982, M. Fritz (MF). *BRAZIL:* PARA: 1 F, Rolandia, III-1975, M. Alvarenga (Townes). MINAS GERAES: 4 F, 3 M, Araxá, 22-IV-1965, C. Elias (UFPR); 1 M, Pratapolis, IV-1961, C. Elias (UFPR); 1 M, Perdizes, 8-IV-1965, C. Elias (UFPR). PARANA: 1 M, São José dos Pinhais, 18-XI-1966, Laroca and Antoni (UFPR); 2 F, Curitiba, VI and IX-1961, S. Laroca (UFPR); 2 F, 1 M, Curitiba, 5-I-1955, C. D. Michener (KU); 1 F, Curitiba, 8-II-1974, J. G. Rozen and R. C. Thompson (AMNH); 1 F, Campina Grande, nr. Curitiba, II-14-1966, H. and M. Townes (Townes). SANTA CATARINA: 1 F, Nova Teutonia, III-1974, F. Plaumann (BMNH); 12 M, Nova Teutonia, XI-1951, F. Plaumann (KU).

Doeringiella cochabambina sp. nov.
(Fig. 49)

This species is closely allied to *arechavaletai*, *paranensis* and *gigas*. The female is not known but is expected to have a reduced pseudopygidial area. The male is distinguished from *arechavaletai* and *paranensis* by having its head and thorax wholly covered with white, erect hairs and by the shape of the scape, and from *gigas* by the metasomal color pattern and the nonreduced fringe on S5. The specific name is based on the type locality.

Holotype male. Length 13.5 mm; length of forewing 10.3 mm. (a) Integument black, center of mandible red, tarsi brownish. Wings ferrugineous, darkened apically. (b) Face with long, appressed, white hairs; shorter white hairs on scape, labrum and gena; long, erect whitish hairs on vertex, occipital region, most of thorax and propodeum; legs also with whitish hairs; metasoma with pubescence other than maculations very short, grayish; sternal fringes pale brown. (c) Maculations on thorax blending with general whitish pilosity; notaular spots fused forming a single central patch, posterior scutal band recognizable; T1-T6 with creamy apical bands, on T5-T6 less marked. (d-e, g) As in *arechavaletai*. (h) Frontal carina keeled, beginning immediately below anterior ocellus and surpassing lower level of sockets. (i) Paraocular carina reaching lower tangent of anterior ocellus. (j) Upper sector of preoccipital carina absent; vertex steep behind ocelli, each posterior ocellus separated from rear margin of head by a distance less than its maximum diameter. (l) Labrum 0.69 times as long as wide; denticles separated by 0.25 times labral length; longitudinal carina and apical point present. (n) Scutellum bigibbous with strong longitudinal impression; axilla produced as strong tooth. (o) Supraspiracular carina strong, continued along postero-lateral angle of propodeum, ending in conspicuous tubercle. (s) Length of vein r subequal to base of second submarginal cell. (u) Proportion of LID to UID 0.85; AOD to IAD 0.48. (v) Scape swollen, 0.64 times UID; as long as the 4.25 basal flagellomeres together; proportion of first and second flagellomeres together to scape 0.54; cavity wider than entrance hole. (w-y) As in *arechavaletai*.

Material studied. Holotype male, *BOLIVIA:* Cochabamba, 12-III-1957 (UFPR).

Doeringiella coelicera sp. nov.
(Fig. 54)

This species may be most closely related to *baeri* or to the *centuncula-hebes* group; the lack of the female prevents a more accurate placement. It is characterized by the swollen scape, as long as the basal 2.6 flagellomeres, the propodeum with long hairs, the legs mostly red, the pale metanotal tuft, the metasoma with grayish general pubescence and cream-colored maculations. The specific name, concave in Latin, refers to the shape of the male scape.

Holotype male. Length 9.8 mm; length of forewing 7.9 mm. (a) Integument black, except following red: center of mandible, base of scape, pedicel, flagellum (but 5 last flagellomeres darker), pronotal lobe, tegula, anterior femur, middle and hind femora except black undersides, tibiae and tarsi. Wings ferrugineous, darker towards apices, veins reddish. (b) Long appressed white hairs on face, erect on rest of head; thorax with mixed short, appressed, and long, erect, whitish hairs; metanotal tuft pale; propodeum completely covered with dense, long white hairs; scape and legs with white hairs; metasoma with pubescence other than bands grey; sternal fringes yellowish. (c) Maculations cream-colored, of short, appressed hairs; pronotal band interrupted

medially; notaular spots confluent, forming transverse band; posterior scutal band reduced to lateral spot; no other maculations on thorax; T1-T2 with white apical bands. (d-i) As in *angulicornis*. (j) Preoccipital carina complete. (l) Labrum 0.63 times as long as wide; denticles separated by 0.23 times labral length; no upper tubercles, small apical point present. (n) Longitudinal impression of scutellum weak; axilla triangular with moderate tooth. (o) Supraspiracular carina concave above spiracle, continued along posterolateral angle of propodeum as low ridge. (s) Length of vein r 0.7 times base of second submarginal cell. (u) Proportion of LID to UID 0.80; AOD to IAD 0.38. (v) Scape swollen, 0.52 times UID; as long as the basal 2.6 flagellomeres together; proportion of first and second flagellomeres together to scape 0.75; cavity wider than entrance hole. (w-y) As in *angulicornis*, but hairs on underside of middle femur longer than apical femoral width.

Material studied. Holotype male from *ARGENTINA:* Tucuman: Trancas, San Pedro de Colalao, 30-III-1949, Guanuco (IML).

Doeringiella crassicornis (Friese)
(Figs. 11, 32, 39, 42, 53)

Epeolus crassicornis Friese, 1908: 83-84. Lectotype female, by present designation, from Argentina, Salta, 2000 m, 3-1905, Steinbach col., (ZMB, examined) Jörgensen, 1909: 219.

Epeolus bizonatus crassicornis: Jörgensen, 1912a: 315; 1912b: 139.

Doeringiella bizonata: Moure, 1954: 264 (in part, not *D. bizonata* Holmberg).

This species has been confused with *bizonata*, as noted in the synonymy; it can be readily distinguished from that and other species that have males with swollen scapes by the bare propodeal surface at the sides of the metapostnotum, with short, appressed hairs on the posterolateral angles; this character is shared with *indecissa*, from which it is distinguished by having T1 with an apical band and by the kidney-shaped entrance hole of the male scape. The legs, pedicel and first flagellomere vary from reddish to black; there is no geographic correlation.

Female. Length 9.0-12.5 mm (n = 6, m = 11.3, lectotype 11); length of forewing 7.7-10.0 mm (n = 6, m = 9.2, lectotype 9.5). (a) Integument black; center of mandible and legs dark red to black; pedicel and first flagellomere reddish; tegula reddish, translucent. Wings infuscated, forewing darkened on costal margin, veins dark brown. (b) Hairs around antennal socket yellow; supra-antennal area, vertex and occipital area with long, brown hairs; clypeus and labrum with short, white hairs. Thorax, legs and metasoma with short, white to grayish hairs, denser on hind coxa and tibia; metanotal tuft pale; posterolateral angles of propodeum with semiappressed white hairs. (c) Maculations of short, appressed, pale yellow hairs; pronotal band complete or briefly interrupted medially; notaular spots rounded, somewhat extended posteriorly, contiguous with middle line; posterior scutal band complete, not extended anteriorly; tegula covered on anterior third; mesepisternal band briefly interrupted behind level of pronotal lobe; scutellar and metanotal bands complete; T1 with apical band, sometimes interrupted medially; T2 with apical band complete. (d) In general with fine and regular punctuation; middle of mesepisternum with punctures 0.025-0.040 mm, separated by 1/2 to 1/5 the smaller diameter, some scattered wider interspaces present. (e) Metapostnotum with upper rugose band wider than metanotum, finely punctured. Propodeum at sides of metapostnotum shiny and usually bare (lectotype with 4-5 scattered punctures). (f) Proportion of LID to UID 0.69-0.74 (n = 6, m = 0.72, lectotype 0.74); AOD to IAD 0.55-0.65 (n = 6, m = 0.61, lectotype 0.61). (g) Paraocular area swollen between antennal socket and upper ocular third. Ocellocular area flat. (h) Frontal carina high, keeled, beginning one ocellar diameter below anterior ocellus and surpassing lower level of antennal sockets; elevation between sockets with sides slightly convex. (i) Paraocular carina ending below lower tangent of anterior ocellus. (j) Preoccipital carina sharp, complete, angle well developed. (l) Labrum 0.56-0.62 times as long as wide (n = 6, m = 0.59, lectotype 0.62); apical denticles separated by 0.31-0.41 times labral length (n = 6, m = 0.35, lectotype 0.37); apical point and short apical carina present. (m) Scape 0.37-0.41 times UID (n = 6, m = 0.39, lectotype 0.41); proportion of first and second flagellomeres together to scape 0.89-1.03 (n = 6, m = 0.94, lectotype 0.90); section of scape on apical third with plical surface flat to slightly concave. (n) Longitudinal impression of scutellum weak; axilla short, triangular. (o) Supraspiracular carina well developed, continued along postero-lateral angle of propodeum as low ridge. (p) Apex of S5 not bent down. (q) T5 without basal patch of hairs. Pseudopygidial area 0.85-0.95 as long as apical width. (r) Hind basitarsus near base 1.66-1.82 as wide as apex. (s) Length of vein r 0.8-0.9 times base of second submarginal cell.

Male. Length 9.1-12.6 mm (n = 12, m = 11.24); length of forewing 7.8-10.1 mm (n = 12, m = 9.24). (t) Color and vestiture similar to those of female. (u) Proportion of LID to UID 0.75-0.80 (n = 8, m = 0.78); AOD to IAD 0.31-0.37 (n = 8, m = 0.34). (v) Scape swollen, 0.51-0.56 times UID (n = 8, m = 0.54), as long as the basal 3-3.3 flagellomeres together; proportion of first and second flagellomeres together to scape 0.62-0.69 (n = 8, m = 0.66); cavity wider than entrance hole. (w) Fringes on S3-S5 occupying the central two thirds; fringe on S5 with curled hairs that surpass posterior margin of sternum. (x) Under-

side of middle femur with long hairs; of posterior femur with short hairs and punctures on the basal 4/5. (y) Dorsal edges of penis continuously sclerotized; without lamella. Volsella present, hairy.

Material studied. 28 F and 51 M from *ARGENTINA:* provinces of Salta, Tucumán, Catamarca, La Rioja, Córdoba, Buenos Aires, San Luis, San Juan and Mendoza (fig. 11). Collection dates are from mid October to late January. Flower records: *Prosopis alba*, *Prosopis chilensis*, *Medicago sativa*, *Verbesina encelioides* and *Verbesina encephaloides*.

Doeringiella crassipes sp. nov.
(Fig. 21)

This species can be recognized by the dense covering of short, appressed hairs on the posterior surface of the propodeum; the strong, complete preoccipital carina; the infuscated wings and the tuberculiform elevation between the antennal sockets of the female. The male has a unique hind tibia, notably swollen; the specific name refers to this character.

Holotype female. Length 9.0 mm; length of forewing 7.0 mm. (a) Integument mostly black; labrum, scape, pronotal lobe, tegula and legs in part brownish; first flagellomere light brown. Wings infuscated, forewing with subapical hyaline spot apicad from closed cells. (b) Hairs around antennal sockets pale yellow; short, appressed, white hairs on clypeus, labrum, gena, venter of thorax and legs; most of thorax and metasoma with pubescence other than maculations brown to grayish, paler on mesopleura and sides of T1; propodeum with dense, appressed, brown hairs that narrowly border metapostnotum. (c) Maculations of short, appressed, yellow hairs; pronotal band medially interrupted; notaular spots small; posterior scutal and metanotal bands complete; scutellum with pale hairs at sides; mesepisternal band consisting of spot below pronotal lobe and band from level of scrobe to base of middle coxa; T1 with lateral band expanded laterally; T2 with apical band weak, narrow. (d) Middle of mesepisternum with punctures 0.025-0.035 mm, interspaces half the smaller diameter. Punctures on scutum smaller. (e) Upper rugose band of metapostnotum as wide as metanotum; longitudinal impression weak. Propodeum at sides of metapostnotum densely punctured. (f) Proportion of LID to UID 0.71; AOD to IAD 0.61. (g) Paraocular and supraantennal areas forming a continuous depression. (h) Frontal carina beginning half ocellar diameter below anterior ocellus, surpassing lower level of antennal sockets, lower sector blunt; elevation between sockets tuberculiform, with sides convex. (i) Paraocular carina reaching lower tangent of anterior ocellus. (j) Preoccipital carina complete, strong. (l) Labrum 0.56 times as long as wide; apical denticles separated by 0.31 times labral length; no upper tubercles, apical point small. (m) Scape 0.38 times UID; first and second flagellomeres together as long as scape; sub-basal angle weak, apical third of plical surface not concave. (n) Longitudinal impression of scutellum weak; axilla triangular, produced as moderate tooth. (o) Supraspiracular carina blunt, continued along postero-lateral angle of propodeum as low ridge. (p) Apex of S5 bent down. (q) T5 with short hairs denser on basal central area, but not forming a definite patch. (s) Length of vein r 0.7 times base of second submarginal cell.

Male. Length 8.7-11.3 mm (n = 2); length of forewing 6.7-7.6 mm. (t) Color and vestiture similar to those of female, but hairs on face white, hairs on propodeum partly pale, T2 with apical band complete, sternal fringes pale. (u) Proportion of LID to UID 0.77-0.78; AOD to IAD 0.42-0.44. (v) Scape not swollen, similar to that of female, 0.40-0.42 times UID; proportion of first and second flagellomeres together to scape 0.92-0.96. (w) Hairs of fringe on S5 barely surpass posterior margin of sternum. (x) Hind tibia notably swollen, approximately 2.5 times as long as apical width. Middle femur with erect hairs on underside shorter than apical width; hind femur mostly bare on underside. (y) Basal half of dorsum of penis only partly sclerotized; lamella present. Volsella present, hairy.

Material studied. ARGENTINA: SALTA: Holotype female, Rosario de Lerma, II-1983, M. Fritz (MACN); 1 male paratype, Coronel Moldes, 28-XI-1947, R. Golbach (IML). CORDOBA: 1 male paratype, Quebrada Honda, near Uquillo, 7-I-1977, L. Stange (IML).

Doeringiella crinita sp. nov.
(Figs. 17, 41, 64a)

This species resembles *burmeisteri* in size and color, but lacks the mesepisternal band, the female S5 is slightly bent down apically, the male scape has long, erect hairs on the plical and the opposite surfaces and the male S5 has a fringe as well developed as that on S4. The female may be confused with *pilicornis*, from which it is distinguished by the non-tuberculiform elevation between the antennal sockets, the apical rather than preapical denticles of the labrum and the shape of the female S5. The specific name refers to the hirsute head of the male.

Female. Length 7.0-9.8 mm (n = 4, m = 8.4,

holotype 9.8); length of forewing 6.5-8.0 mm (n = 4, m = 7.3, holotype 8.0). (a) Integument black; central part of mandible red, tegula brownish, part of first flagellomere and base of second light red. Wings infuscated, darker towards apices. (b) Hairs around antennal sockets pale yellow, vertex and occipital region with erect, brown hairs; whitish hairs on clypeus, labrum, venter of thorax, legs and metasomal sterna; hairs on labrum long; rest of thorax and metasoma with pubescence other than maculations short, brown to grayish; metanotal tuft pale; hairs on propodeum short, restricted to posterolateral angles. (c) Maculations of short, appressed, yellow hairs; pronotal band interrupted medially; notaular spots small; posterior scutal band complete, narrow; scutellar band a small central stripe; some pale hairs below pronotal lobe; T1-T2 with apical bands. (d) Middle of mesepisternum with even punctures, diameter 0.025-0.030 mm, separated by interspaces half the smaller diameter. (e) Upper rugose band of metapostnotum as wide as metanotum; longitudinal impression distinct. Propodeum at sides of metapostnotum microstriated, without punctures. (f) Proportion of LID to UID 0.72-0.74 (n = 4, m = 0.73, holotype 0.74); AOD to IAD 0.61-0.66 (n = 4, m = 0.65, holotype 0.66). (g) Paraocular and supra-antennal areas forming continuous moderate depression. (h) Frontal carina beginning one to one and one half times ocellar diameter below anterior ocellus, reaching lower level of antennal sockets; elevation between sockets with sides slightly concave. (i) Paraocular carina reaching lower tangent of anterior ocellus. (j) Preoccipital carina complete, angle low. (l) Labrum 0.57-0.63 times as long as wide (n = 4, m = 0.59, holotype 0.58); apical denticles separated 0.26-0.31 times labral length (n = 4, m = 0.29, holotype 0.26); no upper tubercles nor longitudinal carina, apical point present. (m) Scape 0.36-0.38 times UID (n = 4, m = 0.37, holotype 0.36); proportion of first and second flagellomeres together to scape 1.16-1.19 (n = 4, m = 1.17, holotype 1.19); no sub-basal angle, cross-section of scape in apical third round. (n) Longitudinal impression of scutellum weak; axilla triangular, projected as small tooth. (o) Supraspiracular carina low, restricted to top of spiracle. (p) Apex of S5 slightly bent down. (q) T5 with short hairs denser on basal central area. Pseudopygidial area 0.65-0.7 times as long as apical width. (s) Length of vein r 0.6-0.75 times base of second submarginal cell.

Male. Length 7.0-10.0 mm (n = 6, m = 8.8); length of forewing 6.1-8.1 (n = 6, m = 7.1). (t) Color and vestiture similar to those of female, but face with long, appressed, silvery hairs; long erect white hairs on labrum, vertex and scape; sternal fringes pale. (u) Proportion of LID to UID 0.75-0.80 (n = 6, m = 0.77); AOD to IAD 0.31-0.39 (n = 6, m = 0.36). (v) Scape not swollen, 0.42- 0.45 times UID (n = 6, m = 0.44); proportion of first and second flagellomeres together to scape 0.9-1.0 (n = 6, m = 0.95); plical surface evenly curved, with erect hairs as long as diameter of pedicel. (w) Fringe on S5 with long, apically curled hairs that surpass posterior margin of sternum, similar to fringes on S3-S4; on S2 also a fringe, but less developed. (x) Middle femur with erect hairs on underside longer than apical width; hind femur with short erect hairs. (y) Basal half of penis only partly sclerotized dorsally; lamella present. Volsella present, hairy.

Material studied. Holotype female from *ARGENTINA:* Tucuman: Dpto. Leales, Los Puestos, 11-IV-1967, A. Willink (IML). Paratypes: *ARGENTINA:* Jujuy: 1 M, Yuto, 30-XI-1953, A. Ogloblin (MLP). Salta: 1 M, La Viña, III-1985, M. Fritz (MF); 1 M, Tablillas, I-1945, A. Martínez (MLP). Tucuman: 5 M, same data as holotype (IML, KU, MACN); 1 M, Dpto. Tafí, Horco Molle, XI-19-1970, C. Porter (IML); 1 M, San Pedro de Colalao, 9-III-1949, Guanuco (IML); 1 F, 1 M, San Pedro de Colalao (MACN); 1 M, Trancas, Tacanas, I-1947, Arnau (IML); 1 M, Tacanas, I-1947 (UFPR). Catamarca: 1 M, Rodeo, 1150 m, 10-I-1959, R. Golbach (IML); 1 M, Las Viñas, 9-XI-1942, A. Ogloblin (MLP). La Rioja: 2 F, La Torre, 7-III-1970, Porter and Stange (IML); 1 M, Olta, 25-XI-1941 (MLP).

Doeringiella gayi (Spinola)
(Figs. 7, 11, 20, 43)

Epeolus gayi Spinola, 1851: 188-189. Female and male from Chile, Coquimbo, Provincias del Norte (Types not examined). Claude-Joseph, 1926: 266-267. Michener, 1953: 1072.

Triepeolus fazi Cockerell, 1925: 493-494. Lectotype male, by present designation, from Chile Central, A. Faz (AMNH, examined) **Synon. nov.**

Triepeolus gayi: Cockerell, 1925: 494.

Doeringiella (Orfilana) gayi: Moure, 1954: 267-268.

This common Chilean species is easily distinguished by its color pattern of creamy-yellowish hairs. The apical bands on T1 and T2 are expanded laterally, leaving a central, semicircular black area on T1. The mesepisternal band is of long, erect hairs. The genitalia associate *gayi* with *tricolor* and *speciosa*.

The specimen of *fazi* preserved in the AMNH agrees perfectly with *gayi*; the color differences mentioned by Cockerell are due to dirt. Since it is not evident from the description how many specimens were studied by Cockerell and there are specimens with the same label in the USNM and the BMNH, this specimen is now labelled lectotype; it was labelled as "type" by Cockerell.

Female. Length 8.0-11.7 mm (n = 8, m = 10.5); length of forewing 6.6-8.8 mm (n = 8, m = 8.1).

(a) Integument black, except the following light red: labrum, base of mandible, antenna, pronotal lobe, tegula, femora in part, tibiae and tarsi. Wings slightly infuscated with dark apical band; veins reddish to brown. (b) Hairs cream-colored, long and erect around antennal socket, labrum, vertex, occipital region and propodeum, scattered on most of thorax; short and appressed on clypeus, gena and legs beyond coxae; venter of thorax and coxae with white appressed hairs; pubescence of metasoma other than maculations black on terga, grayish on sterna. (c) Maculations of cream-colored hairs but of different length; pronotal band and round notaular spots with semiappressed hairs; entire mesepisternal band, bunch of hairs behind pronotal lobe and spot on scutum before tegula of long, erect hairs; posterior scutal, scutellar and metanotal bands complete, of short appressed hairs, scutellar band usually prolonged basally along longitudinal impression; maculations of metasoma of very short, appressed hairs; T1 with apical band greatly expanded laterally, leaving a semicircular black area; bands on T2-T4 decreasingly expanded laterally, sometimes interrupted medially; T5 with lateral spot. (d) Middle of mesepisternum with punctures 0.045-0.06 mm in diameter, interspaces irregular, some scattered interspaces as wide as punctures. On scutum punctures even, smaller. (e) Upper sculptured band of metapostnotum as wide as metanotum, punctate; longitudinal impression distinct. Propodeum at sides of metapostnotum with strong punctures and hairs. (f) Proportion of LID to UID 0.70-0.76 (n = 8, m = 0.73); AOD to IAD 0.67-0.70 (n = 8, m = 0.68). (g) Paraocular area between antennal socket and upper ocular third moderately swollen. (h) Frontal carina beginning one ocellar diameter below anterior ocellus and surpassing lower level of antennal sockets; elevation between sockets with sides more or less straight. (i) Paraocular carina ending below lower tangent of anterior ocellus. (j) Preoccipital carina complete. (l) Labrum 0.57-0.64 times as long as wide (n = 8, m = 0.59); upper tubercles moderate to strong, sometimes prolonged apicad by a carina; apical denticles separated by 0.28-0.37 times labral length (n = 8, m = 0.32); small apical point present. (m) Scape 0.33-0.37 times UID (n = 8, m = 0.35); proportion of first and second flagellomeres together to scape 1.0-1.13 (n = 8, m = 1.07); sub-basal angle present. (n) Longitudinal impression of scutellum distinct; axilla triangular, projecting as short tooth. (o) Supraspiracular carina strong, concave, prolonged along posterolateral angle of propodeum as low ridge. (p) Apex of S5 bent down. (q) T5 with short hairs denser on basal central area, but not forming a definite patch. Pseudopygidial area 0.75-0.80 times as long as apical width, with apical band of slender hairs. (s) Length of vein r 0.7-0.8 times base of second submarginal cell.

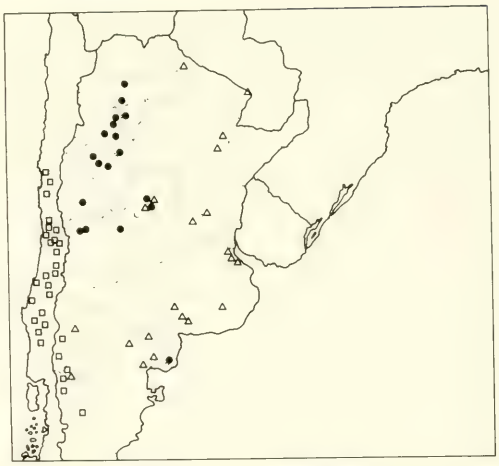


FIG. 11. Distributions of *Doeringiella crassicornis* (dots), *D. gayi* (squares) and *D. holmbergi* (triangles).

Male. Length 9.0-10.6 mm (n = 5, m = 10.2); length of forewing 7.0-8.8 mm (n = 5, m = 8.1). (t) Color and vestiture similar to those of female, but more hirsute, face with silvery appressed hairs, T1-T6 banded, sternal fringes pale. (u) Proportion of LID to UID 0.76-0.80 (n = 5, m = 0.78); AOD to IAD 0.42-0.50 (n = 5, m = 0.45). (v) Scape not swollen, 0.38-0.42 times UID (n = 5, m = 0.40); proportion of first and second flagellomeres together to scape 0.90-1.03 (n = 5, m = 0.95); sub-basal angle strong. (w) Fringe on S5 with straight hairs that barely surpass posterior margin of sternum. (x) Middle femur with erect hairs on underside as long as apical width; hind femur with erect hairs. (y) Basal half of penis only partly sclerotized dorsally; lamella present. Volsella present, hairy.

Material studied. 64 F and 38 M from *ARGENTINA:* provinces of Neuquén, Rio Negro and Chubut; from *CHILE:* provinces of Coquimbo, Aconcagua, Valparaíso, Santiago, O'Higgins, Curicó, Talca, Maule, Linares, Ñuble, Concepción, Malleco, Bio Bio and Cautín (Fig. 11). Collection dates are from August to February.

Doeringiella gigas (Spinola)
(Figs. 15, 27, 47, 64b)

Epeolus gigas Spinola, 1851: 187-188. Female and male from Chile, Santa Rosa and Coquimbo (Types not examined). Claude-Joseph, 1926: 265.
Doeringiella (Doeringiella) gigas: Moure, 1954: 264.

This species belongs in the *bizonata* group. It is easily recognized by the hirsute body, the extensive creamy-yellowish maculations on the metasoma, the light red legs and flagellum, the medially humped labrum with apical denticles widely separated and the male S5 with the fringe reduced medially. I have not seen type material, but there is no doubt about the identity of this characteristic Chilean species.

Female. Length 11.3-13 mm (n = 6, m = 12.5); length of forewing 8.5-10.7 mm (n = 6, m = 9.9). (a) Integument black, except the following light red: labrum, base of mandible, antenna, pronotal lobe, tegula and legs beyond trochanters; femora, labrum and scape vary from light red to completely black. Wings slightly infuscated with dark apical band; veins brown. (b) Body hirsute; appressed hairs on face, labrum, gena and most of legs; rest of head, most of thorax and propodeum with long erect hairs; metasoma with hairs other than maculations black on terga, cream-colored on sterna. (c) Maculations of cream-colored hairs of variable length; mesepisternal band of long hairs partly confounded with general pilosity of mesopleura; pronotal band complete; notaular spots united forming cuneiform patch of semiappressed hairs; posterior scutal, scutellar and metanotal bands complete, of short appressed hairs; scutellar band prolonged basally along longitudinal impression; maculations on metasoma of very short appressed hairs, on T1 enclosing central transverse black oval; T2 with apical band greatly expanded laterally, T3-T4 with apical bands; T5 with lateral spot. (d) Middle of mesepisternum with punctures 0.035-0.05 mm in diameter, interspaces narrow. (e) Upper sculptured band of metapostnotum shorter than metanotum; longitudinal impression strong. (f) Proportion of LID to UID 0.70-0.75 (n = 6, m = 0.73); AOD to IAD 0.66-0.73 (n = 6, m = 0.69). (g) Paraocular area moderately swollen. (h) Frontal carina keeled, beginning one ocellar diameter below anterior ocellus, ending above lower level of antennal sockets in a small elongated shiny spot; elevation between sockets with sides slightly convex. (i) Paraocular carina reaching lower tangent of anterior ocellus. (j) Upper sector of preoccipital carina absent, surface behind ocelli steep. (l) Labrum 0.60-0.69 times as long as wide (n = 6, m = 0.64); no upper tubercles, center of labrum convex; apical denticles separated by 0.40-0.48 times labral length (n = 6, m = 0.45); apical point present. (m) Scape 0.39-0.45 times UID (n = 6, m = 0.42); proportion of first and second flagellomeres together to scape 0.78-0.88 (n = 6, m = 0.82); sub-basal angle weak, plical surface on apical third flat to slightly concave. (n) Scutellum bigibbous with strong longitudinal impression; axilla projected as strong tooth. (o) Supraspiracular carina strong, concave, continued along postero-lateral angle of propodeum, ending in moderate to strong tubercle. (p) Apex of S5 not bent down. (q) T5 without basal patch of hairs. Pseudopygidial area poorly defined, 0.3-0.4 times as long as wide; of slender hairs. (s) Length of vein r 0.8-0.9 times base of submarginal cell.

Male. Length 11.5-15.5 mm (n = 5, m = 12.9); length of forewing 9.1-10.5 mm (n = 5, m = 9.8). (t) Color and vestiture similar to those of female, but more hirsute, face with white appressed hairs, T6 apically banded, sternal fringes pale. (u) Proportion of LID to UID 0.74-0.80 (n = 5, m = 0.78); AOD to IAD 0.38-0.46 (n = 5, m = 0.42). (v) Scape swollen, 0.53-0.56 times UID (n = 5, m = 0.55), as long as the basal 3.5-3.75 flagellomeres together; proportion of first and second flagellomeres together to scape 0.58-0.61 (n = 5, m = 0.59); cavity wider than entrance hole. (w) Sternal fringes of straight, dense hairs, fringe on S5 medially reduced, barely surpassing posterior margin of sternum. (x) Middle femur with erect hairs on underside as long as apical width; hind femur with dense, erect hairs. (y) Dorsal edges of penis parallel, continuously sclerotized; without lamella. Volsella indicated by faint sclerotization.

Material studied. CHILE: 1 F, 1912, H. Flam (BMNH); 2 M, 1902, P. Herbst (MCZ). Coquimbo: 1 F, La Serena, 29-XII-1939 (BMNH); 1 F, La Serena, XII-1946 (CAS); 1 F, 1 M, La Serena, 14-I-1952 and 8-XII-1957, Wagenknecht (MACN). Valparaiso: 1 F, Marga Marga, 25-I-1921, P. Herbst (AMNH); 1 M, El Salto, XII-1901, P. Herbst (MCZ); 1 F, 3 M, Reñaca, I-1933, Reed (CAS). Bio Bio: 1 F, Bio Bio, I-1953, Fritz (MLP); 1 M, Los Angeles, III-1949, Fritz (MLP). Malleco: 1 M, Angol, 20-I-1927 (AMNH).

Doeringiella guttata sp. nov.
(Figs. 3, 21, 29)

This is the only *Doeringiella* species that has the integument of the head and thorax with extensive red markings. Usually the labrum, the clypeus and the supraclypeal area, part of the pronotum, the scutellum and the metanotum are red. It is also characterized by the presence of short, appressed hairs on the metapostnotum and the propodeum. The specific name refers to the rounded pseudopygidial area in the female.

Female. Length 8.0-9.3 mm (n=6, m=8.53, holotype 8.0); length of forewing 6.1-7.0 mm (n=6, m=6.4, holotype 6.2). (a) Integument black, except the following red: base of mandible, labrum, clypeus, supraclypeal area, scape, pedicel, flagellomeres 1- 3, pronotal lobe (entire pronotum in some specimens), scutum before tegula, tegula, scutellum, metanotum and legs; metapostnotum and propodeum may be black or reddish (reddish in holotype); coxae vary from black to red (black in the holotype). Wings slightly infuscated with dark apical band, veins brown. (b) Hairs around antennal sockets pale yellow; body in general with very short appressed whitish hairs, dense on propodeum and lateral portion of metapostnotum, brown on metasomal terga. (c) Maculations pale yellow, of short appressed hairs; pronotal band complete; notaular spots small; posterior scutal and metanotal bands complete; scutellar band central and lateral spots; mesepisternal band from level of scrobe to base of middle coxa; T1-T2 with apical bands; T3-T4 apically and T5 laterally with poorly defined bands. (d) Middle of mesepisternum with punctures 0.02-0.03 mm, interspaces shiny, 1/3 to 1/4 diameter of punctures. (e) Upper sculptured band of metapostnotum shorter than metanotum, punctured; longitudinal impression weak. Propodeum at sides of metapostnotum with dense punctures bearing small hairs. (f) Proportion of LID to UID 0.66-0.71 (n=6, m=0.68, holotype 0.67); AOD to IAD 0.65-0.69 (n=6, m=0.67, holotype 0.68). (g) Paraocular and supra-antennal areas forming continuous moderate depression. (h) Frontal carina sharp, beginning one ocellar diameter below anterior ocellus and reaching lower level of sockets; elevation between sockets with sides concave. (i) Paraocular carina ending below lower tangent of anterior ocellus. (j) Preoccipital carina complete, sharp. (l) Labrum 0.60-0.66 times as long as wide (n=6, m=0.62, holotype 0.64); upper tubercles moderate; apical denticles separated by 0.27- 0.35 times labral length (n=6, m=0.37, holotype 0.35); apical point present. (m) Scape 0.34-0.37 times UID (n=6, m=0.36, holotype 0.34); proportion of first and second flagellomeres together to scape 1.04-1.12 (n=6, m=1.07, holotype 1.09); subbasal angle weak, apical third of plical surface not concave. (n) Longitudinal impression of scutellum weak; axilla triangular, projected as short tooth. (o) Supraspiracular carina low, prolonged as ridge along posterolateral angle of propodeum. (p) Apex of S5 bent down. (q) T5 with basal central patch of denser hairs. Pseudopygidial area oval, longer than wide. (s) Length of vein r 0.7-0.8 times base of second submarginal cell.

Male. Length 6.5-11.0 mm (n=2); length of forewing 5.9-7.7 mm. (t) Color and vestiture similar to those of female, face with silvery hairs, sternal fringes pale. (u) Proportion of LID to UID 0.70-0.74; AOD to IAD 0.41-0.43. (v) Scape not swollen, similar to that of female, 0.44-0.46 times UID; proportion of first and second flagellomeres together to scape 0.87-0.96. (w) Fringe on S5 with curled hairs that surpass posterior margin of sternum. (x) Middle femur with erect hairs on underside longer than apical width; hind femur also with erect hairs. (y) Basal half of dorsum of penis only partly sclerotized; lamella present. Volsella present, hairy.

Material studied. ARGENTINA: Holotype female, LA RIOJA, 7 km S Villa Casana, 10-XII-1971, Porter and Stange (IML). Paratypes: SALTA: 1 M, La Viña, I-1968, M. Fritz (MF). TUCUMAN: 1 F, Tucumán city, I-1947 (IML); 36 F, 11 km North Dique Cadillal, 18-XI-1983, R. B. Roberts (Roberts, KU, MACN); 1 F, Horco Molle, 15 km W Tucumán, 500 m, 5-XI-1983, R. B. Roberts (Roberts). SANTIAGO DEL ESTERO: 1 F, Los Tigres, 11-I-1970, R. Golbach (IML); 1 F, R. Salado, 10 km Colonia Dora, 17-25-XI-1979, C. and M. Vardy (BMNH). LA RIOJA: 1 F, 26-XI-1941 (MLP); 2 F, Los Tambillos, 29-XI-1977, Willink and Fidalgo (IML). CORDOBA: 1 F, 27-XII-1970, M. Fritz (UFPR). SAN JUAN: 1 F, Albardón, 12-XII-1971, Porter and Stange (IML). SAN LUIS: 1 M, San Jerónimo, XI-1972, G. Williner (MACN). RIO NEGRO: 2 F, Bal. Las Grutas, 14-I-1968, J. and L. Stange (IML, KU); 1 F, San Antonio Oeste, M. Fritz (MF).

Doeringiella hebes sp. nov.
(Fig. 37)

This species is closely allied to *centuncula*, from which it is distinguished by the rounded axilla, the black scutellum and the pattern of maculation of the metasoma. The male is not known but is expected to have a swollen scape. The specific name, "blunt" in Latin, refers to the shape of the axilla.

Female. Length 8.6-9.7 mm (n=3, m=9.3, holotype 9.6); length of forewing 6.6-7.3 mm (n=3, m=7.0, holotype 7.3). (a) Integument black, except base of mandible, tegula and legs beyond trochanters red; hind femur partly red. Wings infuscated, darker apically; veins dark brown. (b) White, appressed hairs on labrum, around antennal socket, on legs and sternal region of thorax; most of head, thorax and metasoma with pubescence other than maculations short and dark; metanotal tuft dark; propodeum covered with long, erect, dark hairs. (c) Maculations of short, appressed, white hairs; pronotal band interrupted medially; notaular spots elongate, well separated; posterior scutal band reduced to small central spot; scutellar band narrow; metanotal band interrupted medially; mesepisternal band poorly marked below pronotal lobe; T1 broadly maculate at base, sides and apex, leaving a central black patch; T2-T4 with apical bands, that on T4 interrupted medi-

ally; T5 with lateral spot. (d) Mesepisternum below scrobe with transverse band of close punctures 0.015 mm in diameter, below this band punctures of 0.025-0.040, mm with wide interspaces. (e) Upper sculptured band of metapostnotum as wide as metanotum, rugoso punctured; longitudinal impression weak. Propodeum at sides of metapostnotum with dense punctures and hairs. (f) Proportion of LID to UID 0.74-0.81 (n=3, m=0.77, holotype 0.74); AOD to IAD 0.72-0.76 (n=3, m=0.75, holotype 0.76). (g) Paraocular area not depressed and supra-antennal area slightly so, as in species of *Triepeolus*. Vertex raised, lateral ocelli above level of top of eyes. (h) Frontal carina beginning half ocellar diameter below anterior ocellus, reaching lower level of antennal sockets; elevation between sockets with sides straight. (i) Paraocular carina ending below lower tangent of anterior ocellus. (j) Upper sector of preoccipital carina absent, genal sector weak. (l) Labrum 0.54-0.58 times as long as wide (n=3, m=0.56, holotype 0.58); no upper tubercles; apical denticles separated by 0.24-0.28 times labral length (n=3, m=0.27, holotype 0.24); apical point and longitudinal carina present. (m) Scape 0.36-0.37 times UID (n=3, m=0.363, holotype 0.36); proportion of first and second flagellomeres together to scape 0.92-1.0 (n=3, m=0.95, holotype 0.92); subbasal angle weak. (n) Longitudinal impression of scutellum weak; axilla rounded, not produced at all. (o) Supraspiracular carina small, restricted to top of spiracle. (p) Apex of S5 narrow, bent down. (q) Base of T5 with sharply defined patch of dense hairs. Pseudopygidial area 0.8 as long as apical width, of slender hairs. (s) Length of vein r 0.6-0.66 times base of second submarginal cell.

Material studied. *PERU:* Holotype female, Canta (Departamento Lima), 2800 m, V-1951, Weyrauch, WKW 5984 (IML); 2 female paratypes, same data (KU, IML).

Doeringiella holmbergi (Schrottky)
(Figs. 57, 66, 75)

Doeringiella variegata Holmberg, 1886: 279. Lectotype female, by present designation, no locality label (MACN, examined). Dalla Torre, 1896: 335; Schrottky, 1903: 184.

Epeolus holmbergi Schrottky, 1913: 265. New name for *D. variegata* Holmberg, not *Epeolus variegatus* (Linnaeus).

Triepeolus pruinosus Cockerell, 1917: 478-479. Holotype female, from Argentina, Carcarañá (USNM, examined). Synonymy by Moure, 1955: 126.

Doeringiella (Orfilana) variegata: Moure, 1954: 267; 1955: 126.

There is only one specimen of this species left in the Holmberg collection, preserved in the MACN. It bears a handwritten label by Holmberg "*Doeringiella variegata*", but no other labels. The head is in poor condition. This female is presumed to belong to the original series and is therefore designated lectotype. According to the article 59(b) of the International Code of Zoological Nomenclature the valid name is the replacement name proposed by Schrottky, when he transferred the species to *Epeolus*.

D. silvatica Holmberg, 1886, described from Formosa (Argentina), was synonymized by Moure (1954) with *holmbergi*, but some points of the original description of *silvatica* disagree. I have not seen specimens of *holmbergi* less than 9 mm long; Holmberg says 7 mm for *silvatica*. Specimens of *holmbergi* from northern Argentina (Chaco, Formosa) follow the same color pattern as specimens from Buenos Aires: the apical band of T1 is expanded laterally, the apical bands of T2-T3 are present (the band on T3 is less defined), and the apical band on T4 is absent. The description of *silvatica* indicates apical bands present on T1-T4, that on T1 not expanded laterally. Another species, *burmeisteri*, better fits Holmberg's description of *silvatica*. I prefer to leave the problem pending until more material from Formosa is collected.

Males of this species can be confused with those of *similaris*, specially in northern Patagonia (Rio Negro, Neuquén), where specimens of *holmbergi* have dark legs and antennae. The structure of the penis and the gonostylus will help to distinguish the two species.

Female. Length 9.0-11.5 mm (n=8, m=10.3); length of forewing 6.6-8.1 mm (n=8, m=7.4). (a) Integument black; base of mandible, scape, pedicel, pronotal lobe, tegula and legs dark red to black; first flagellomere light red. Wings slightly infuscated with dark apical band. (b-c) As described for *burmeisteri* but mesepisternal band shorter, from level of scrobe to base of middle coxa; scutellar band as lateral and central spots; apical band on T1 expanded laterally or not, on T2 transverse, distinct, on T3 less defined, paler, on T4 usually absent. (d) Middle of mesepisternum with even punctures, diameter 0.03-0.04 mm, separated by 1/3 to 1/4 of those diameters; on scutum closer and smaller. (e) Upper sculptured band of metapostnotum shorter than metanotum, rugoso-punctate. Propodeum at sides of metapostnotum bare, without punctures. (f) Proportion of LID to UID 0.70-0.75 (n=8, m=0.73); AOD to IAD 0.60-0.68 (n=8, m=0.62). (g) Paraocular and supra-antennal areas forming continuous depression. (h) Frontal carina beginning half ocellar diameter below anterior ocellus, reaching lower level of antennal sockets, lowest sector blunt; elevation between sockets with sides concave. (i) Paraocular carina reaching lower tangent of anterior ocellus. (j) Preoccipital carina usually obliterated near angle,

in some specimens weakly indicated. (l) Labrum 0.56-0.61 times as long as wide (n = 8, m = 0.59); upper tubercles present, frequently prolonged apicad by a carina; apical denticles separated by 0.27-0.35 times labral length (n = 8, m = 0.30); apical point present. (m) Scape 0.34-0.37 times UID (n = 8, m = 0.36); proportion of first and second flagellomeres together to scape 1.0-1.07 (n = 8, m = 1.03); sub-basal angle present, section of plical surface on apical third flat or slightly concave. (n) Longitudinal impression of scutellum weak; axilla triangular, produced as short tooth. (o) Supraspiracular carina concave, prolonged along postero-lateral angle of propodeum as low ridge. (p) Apex of S5 bent down. (q) T5 with basal central patch of dense hairs. Pseudopygidial area 0.85-0.9 times as long as apical width. (s) Length of vein r 0.8-1.0 times base of second submarginal cell.

Male. Length 9.2-12.0 mm (n = 5, m = 10.4); length of forewing 6.1-8.5 mm (n = 5, m = 7.1). (t) Color and vestiture similar to those of female, but face and ventral surface of thorax with silvery hairs; T1-T2 with pale yellow band well marked, on T3-T6 apical bands whitish, more or less distinct depending on specimens; sternal fringes pale. (u) Proportion of LID to UID 0.79-0.81 (n = 5, m = 0.80); AOD to IAD 0.38-0.44 (n = 5, m = 0.40). (v) Scape not swollen , 0.43-0.47 times UID (n = 5, m = 0.44); proportion of first and second flagellomeres together to scape 0.81- 0.94 (n = 5, m = 0.89); sub-basal angle strong and apical third of plical surface usually concave. (w) Fringe on S5 with straight hairs that barely surpass posterior margin of sternum. (x) Middle femur with erect hairs on underside subequal to apical width; hind femur with semiappressed hairs on basal 1/2 to 2/3. (y) Dorsal edges of penis parallel, continuously sclerotized, without lamella. Volsella hairy.

Material studied. 71 F and 174 M from *ARGENTINA:* provinces of Formosa, Chaco, Córdoba, Santa Fe, Entre Rios, Buenos Aires, La Pampa, Rio Negro and Neuquén (Fig. 11). Collection dates are from November to April.

Doeringiella indecissa Holmberg
(Figs. 51, 62)

Doeringiella indecissa Holmberg, 1886b: 281. Types from Formosa, Argentina (lost). Dalla Torre, 1896: 335; Schrottky, 1903: 184.
Epeolus indecissus: Schrottky, 1913: 264.

This species is the only *Doeringiella* that has the transverse band on T1 preapical, a pattern that is also present in some South American *Triepeolus*. The males have the scape swollen, with a unique shallow cavity. This combination of characters makes the species' identity certain, in spite of the loss of the types. The female is further characterized by having the propodeum at the sides of the metapostnotum bare, the S5 not bent down apically and the scape long, 0.43-0.48 times UID.

Female. Length 8.2-10.2 mm (n = 8, m = 9.2); length of forewing 6.6-8.2 (n = 8, m = 7.1). (a) Integument black, in some specimens legs and metasoma partly brownish; first flagellomere, base of second and tibial spurs light red. Wings ferrugineous, infuscated towards apex. (b) Hairs around antennal socket appressed, yellow; hairs erect, brown on supra-antennal area, vertex and occipital region; sparse, white hairs on clypeus, labrum and legs, denser on tibiae and hind coxa; pubescence on thorax and metasoma other than maculations short, white to grayish; metanotal tuft pale; posterolateral angle of propodeum with short appressed white hairs. (c) Maculations white to yellowish, of short appressed hairs; pronotal band interrupted medially; notaular spots rounded; posterior scutal, scutellar and metanotal bands complete; mesepisternal band present, poorly defined below pronotal lobe; T1 with band widely separated from apical margin, in some specimens medially interrupted; T2-T3 with apical bands complete, on T3 medially separated from apical margin; T4 with interrupted apical band. (d) Middle of mesepisternum with punctures 0.025-0.035 mm, interspaces 1/3 to 1/2 of those diameters. (e) Upper rugose band of metapostnotum as wide as metanotum, rugosopunctate; longitudinal impression weak. Propodeum at sides of metapostnotum bare, no punctures. (f) Proportion of LID to UID 0.75-0.85 (n = 8, m = 0.79); AOD to IAD 0.50-0.62 (n = 8, m = 0.56). (g). Paraocular and supra-antennal areas forming continuous moderate depression. (h) Frontal carina high, sharp, beginnning close to anterior ocellus, ending below lower level of antennal sockets; elevation between sockets with sides slightly concave. (i) Paraocular carina ending below lower tangent of anterior ocellus. (j) Preoccipital carina poorly indicated near angle. (l) Labrum 0.57-0.65 times as long as wide (n = 8, m = 0.61); upper tubercles moderate or absent; apical denticles separated 0.30-0.39 times labral length (n = 8, m = 0.36); apical point present. (m) Scape 0.43-0.48 times UID (n = 8, m = 0.46); proportion of first and second flagellomeres together to scape 0.79-0.87 (n = 8, m = 0.84); subbasal angle present, section of plical surface on apical third flat. (n) Longitudinal impression of scutellum weak; axilla triangular, projected as short tooth. (o) Supraspiracular carina strong, concave, continued along postero-lateral angle of propodeum as low ridge. (p) Apex of S5 not bent down. (q) T5 with short hairs denser on central basal area, but not forming a definite patch.

Pseudopygidal area 0.8 times as long as apical width. (s) Length of vein r 0.8-1.0 times base of second submarginal cell.

Male. Length 8.5-10.3 mm (n = 5, m = 9.3); length of forewing 6.6-9.5 mm (n = 5, m = 7.5). (t) Color and vestiture similar to those of female; face and venter of thorax with long appressed white hairs; T2-T6 with apical bands complete; sternal fringes pale. (u) Proportion of LID to UID 0.81-0.87 (n = 5, m = 0.83); AOD to IAD 0.34-0.42 (n = 5, m = 0.37). (v) Scape swollen, 0.56-0.60 times UID (n = 5, m = 0.59), as long as the basal 3.25-3.5 flagellomeres together; proportion of first and second flagellomeres together to scape 0.58-0.60 (n = 5, m = 0.59); cavity completely exposed. (w) Fringe on S5 sparse, hairs surpassing posterior margin of sternum. (x) Middle femur with erect hairs on underside subequal to apical width; hind femur with semiappressed hairs on basal 2/3. (y) Basal half of penis only partly sclerotized dorsally; lamella present. Volsella present, hairy.

Material studied. ARGENTINA: Salta: 1 F, La Viña, III-1984, M. Fritz (MF). Cordoba: 7 F, 13 M, Depto. Calamuchita, El Sauce, XII-1938, M.J. Viana (MACN); 2 F, 1 M, same data (KU); 1 F, Agua de Oro, I-1940, J. De Carlo (KU); 1 F, Argüello, De Carlo and Viana (KU). Santa Fe: 1 M (MACN).

Doeringiella joergenseni (Friese)
(Figs. 25, 70, 74)

Epeolus jörgenseni Friese, 1908: 84. Lectotype female, by present designation, from Argentina, Tucumán, Steinbach (ZMB, examined). Jörgensen, 1909: 219, 1912a: 140, 1912b: 315.
Epeolus joergenseni: Schrottky, 1913: 264. Emend.
Doeringiella (Orfilana) joergenseni: Moure, 1954: 269.

Both sexes of this species are readily distinguished by the hairy scape; the dense, erect hairs are distributed on the plical surface and also on the opposite surface of the scape. The thorax has no maculations, and the metasomal T1-T4 may have narrow apical bands; specimens that lack those bands are wholly black. Further characters are the lack of the sub-basal angle of the scape and the metapostnotum and propodeum separated by a more or less distinct sulcus.

Female. Length 8.7-12.3 mm (n = 8, m = 10.9, lectotype 12.0); length of forewing 7.2-9.2 (n = 8, m = 8.5, lectotype 8.5). (a) Integument black; center of mandible and first flagellomere reddish. Wings yellowish near bases, darker towards apex. (b) With grayish to brown hairs on face, labrum, most of thorax and legs; long, erect, brown hairs on vertex, occipital area, metanotal tuft and propodeum. Scape with long, erect hairs on plical surface as long as half apical width, also erect hairs on opposite surface. (c) No maculations on thorax. Lectotype with T1-T3 with apical yellow bands narrow, T4 with apical band poorly indicated; northern specimens (Jujuy) with no bands, entire metasoma black; southern specimens usually with 4 complete, well developed bands. (d) Middle of mesepisternum with punctures coarse, diameter 0.035-0.05 mm, interspaces narrow; punctures more separated on scutum and scutellum. (e) Metapostnotum with upper rugose band of strong punctures, as wide as metanotum; border with propodeum sharply indicated by sulcus. Propodeum at sides of metapostnotum with scattered punctures bearing long hairs in lectotype, some specimens without such punctures and hairs. (f) Proportion of LID to UID 0.71-0.77 (n = 8, m = 0.74, lectotype 0.74); AOD to IAD 0.65-0.81 (n = 8, m = 0.72, lectotype 0.65). (g) Supra-antennal and paraocular areas moderately depressed. (h) Frontal carina sharp, beginning half ocellar diameter below anterior ocellus and slightly surpassing lower level of antennal sockets, lowest sector blunt; elevation between sockets with sides slightly convex. (i) Paraocular carina reaching lower tangent of anterior ocellus. (j) Upper sector of preoccipital carina near angle indistinct due to punctation. (l) Labrum 0.56-0.65 times as long as wide (n = 8, m = 0.61, lectotype 0.56); upper two-thirds flat, apex bent forwards; no upper tubercles nor longitudinal carina; apical denticles separated by 0.17-0.28 times labral length (n = 8, m = 0.22, lectotype 0.23); apical point present. (m) Scape 0.36-0.40 times UID (n = 8, m = 0.38, lectotype 0.38); proportion of first and second flagellomeres together to scape 1.06-1.17 (n = 8, m = 1.13, lectotype 1.15); plical surface evenly arched, without sub-basal angle. (n) Longitudinal impression of scutellum weak; axilla triangular, produced as moderate tooth. (o) Supraspiracular carina short, restricted to top of spiracle. (p) Apex of S5 bent down. (q) T5 with central basal patch present, of slender, erect hairs. Pseudopygidial area 0.6-0.7 times as long as apical width. (s) Length of vein r 0.6-0.7 times base of second submarginal cell.

Male. Length 8.6-11.5 mm (n = 5, m = 10.2); length of forewing 7.7-8.5 mm (n = 5, m = 8.2). (t) Color and vestiture similar to those of female; face and venter of thorax with white appressed hairs; metasomal terga with six apical bands, fewer, or none. Hairs on scape longer than in female, as long as apical width of scape. (u) Proportion of LID to UID 0.74-0.81 (n = 5, m = 0.79); AOD to IAD 0.28-0.33 (n = 5, m = 0.30). (v) Scape not swollen, similar to that of female, 0.44-0.49 times UID (n = 5, m = 0.46); proportion of first and second flagellomeres together to scape 0.91-1.0 (n = 5, m = 0.95). (w) Fringe on S5 with long curled hairs that surpass posterior margin of sternum. (x) Middle femur with erect hairs on underside shorter than apical

width; hind femur with short appressed hairs. (y) Basal half of penis only partly sclerotized dorsally; lamella present. Volsella present, hairy.

Material studied. ARGENTINA: JUJUY: 2 F, 2 M, La Quiaca, 3400 m, II-1960, R. Golbach (IML); 1 M, Tilcara, 25-I-1948, Monrós and Willink (IML); 1 F, Humahuaca, 24-I-1973, L. Stange (IML); 1 F, Tilcara, V-1986, M. Fritz (MF). SALTA: 1 M, paralectotype, 1200 m, 10-11-1905, Steinbach (ZMB); 1 F, 1 M, Tacuil, 2400 m, 16-31-XII-1968 and 22-II-1967, A. Willink (IML); 1 F, Chicoana, La Gotera, II-1987, M. Fritz (MF). TUCUMAN: 1 F, Tafí del Valle road, 1550 m, 18-III-1974, C. Vardy (BMNH); 1 F, Tafí del Valle, 2000 m, 15-II-1984, A. Willink (IML); 1 M, San Pedro de Colalao, Dpto. Trancas, II-1951 (KU); 3 F, 1 male, Tafí del Valle, El Mollar, I-1986, J. L. Neff (CTMI). CATAMARCA: 1 M, Minas Capillitas, 2600 m, 23-XII-1973, J. L. Neff (CTMI); 1 F, El Suncho, 1850 m, 8-18-II-1957, R. Golbach (IML); 2 females, El Suncho, 18-III-1956, N. Kusnezov (IML). LA RIOJA: 2 F, Guanchín, 15-XII-1971, Porter and Stange (IML). CORDOBA: 1 F, La Falda, 26-II-1966, A. Willink (IML). SAN JUAN: 1 F, El Leoncito, 2400 m, I-1966, Willink and Stange (IML); MENDOZA: 4 F, 3 M, Cacheuta (MACN); 2 F, Tupungato, 25-II-1961, A. Willink (IML); 1 M, Potrerillos, 100 m, 20-I-1947, A. Willink (IML).

Doeringiella oblata sp. nov.
(Figs. 34, 69)

This remarkable species has some unique features: the clypeus is flat, the supraclypeal area is depressed, the forewing has a broad, dark band along the costal margin, and the notaular spots are absent. Other useful characters to distinguish *oblata* are the short, appressed hairs on the propodeum at the sides of the metapostnotum and S5 of the female which is not bent down apically. The specific name refers to the flat face.

Female. Length 9.1-12.5 mm (n = 8, m = 10.8, holotype 10.5); length of forewing 8.4-10.1 mm (n = 8, m = 9.1, holotype 9.5). (a) Thorax black; head and metasoma brownish to black; legs brownish; center of mandible, labrum, scape, pedicel, basal flagellomere, pronotal lobe and tegula light red. Forewing with broad, dark band along costal margin, remainder of wings hyaline, veins dark brown. (b) With brown to grayish hairs, appressed on face, erect on vertex, short and paler on legs and metasoma; thorax and metasomal sterna with sparse stiff pale hairs; metanotal tuft pale; propodeum densely covered with short appressed hairs, similar hairs on lateral portion of metapostnotum. (c) Maculations of short, appressed, pale yellow hairs; pronotal, posterior scutal and metanotal bands complete; mesepisternal band from level of scrobe to base of middle coxa; T1 with apical band, T2 with apical band narrow and broadly interrupted medially, T3 with apical band centrally arched, separated from apical margin. (d) Middle of mesepisternum with small punctures, 0.025-0.030 mm, interspaces 1/4 to 1/5 of those diameters. (e) Upper sculptured band of metapostnotum wider than metanotum, of small dense punctures. Propodeum at sides of metapostnotum punctured, punctures hardly visible due to dense appressed hairs. (f) Proportion of LID to UID 0.66-0.70 mm (n = 8, m = 0.68, holotype 0.67); AOD to IAD 0.74-0.80 (n = 8, m = 0.77, holotype 0.74). (g) Supra-antennal depression shallow due to flattened face. (h) Frontal carina sharp, low, beginning one ocellar diameter below anterior ocellus, ending above lower level of antennal sockets; no elevation between sockets. (i) Paraocular carina ending just below lower tangent of anterior ocellus. (j) Preoccipital carina complete. (k) Clypeus flat, supraclypeal area depressed, as seen laterally not protruding in front of eyes. (l) Labrum 0.52-0.62 times as long as wide (n = 8, m = 0.57, holotype 0.52); upper tubercles moderate; apical denticles separated by 0.32-0.38 times labral length (n = 8, m = 0.34, holotype 0.38); no apical point, between apical denticles emarginate. (m) Scape 0.37-0.43 times UID (n = 8, m = 0.40, holotype 0.40); proportion of first and second flagellomeres together to scape 0.97-1.04 (n = 8, m = 1.02, holotype 1.03); sub-basal angle weak, scape basally compressed; plical surface on apical third flat. (n) Longitudinal impression of scutellum weak; axilla rounded, with small tooth scarcely projecting. (o) Supraspiracular carina a small tubercle on top of spiracle. (p) Apex of S5 not bent down. (q) T5 with short hairs denser on basal central area, but not forming definite patch. Pseudopygidial area as long as wide, rounded. (s) Length of vein r 0.7-0.85 times base of second submarginal cell.

Male. Length 8.2-13 mm (n = 5, m = 10.3); length of forewing 8.0-10.2 mm (n = 5, m = 9.0). (t) Color and vestiture similar to those of female except white hairs on face and sometimes a subapical band on T4; sternal fringes pale. (u) Proportion of LID to UID 0.74-0.80 (n = 5, m = 0.76); AOD to IAD 0.47-0.53 (n = 5, m = 0.49). (v) Scape not swollen, similar to female, 0.45-0.50 times UID (n = 5, m = 0.47); proportion of first and second flagellomeres together to scape 0.84-0.91 (n = 5, m = 0.88). (w) Fringe on S5 with curled hairs that surpass posterior margin of sternum. (x) Middle femur with erect hairs on underside as long as apical width; hind femur with semiappressed hairs. (y) Basal half of penis only partly sclerotized dorsally; lamella present. Volsella present, hairy.

Material studied. Holotype female from *ARGENTINA:* LA RIOJA: Illiar, M. Gómez (MACN). Following paratypes: *ARGENTINA:* SALTA: 1 M, Angastaco, 7-XII-1968, Willink and Stange (IML); 1 M, Rosario de la Frontera, II-1983, M. Fritz (MF); 1 F, La Viña, II-1984, M. Fritz

(MF). Tucuman: 1 F, La Puesta, 20-II-1970 (IML); 1 F, 11 km W Las Cejas, 5-V-1968, L. Stange (IML); 1 M, Amaicha del Valle, XII-11-1964, C. Porter (Porter). Santiago del Estero: 1 F, 1 M, (MACN); 1 M, 30 km S Villa San Martin, XII-29-1975, R. M. Bohart (UCD); 6 F, 1 M, Los Tigres, 11-16-I-1970, R. Golbach (IML); 1 F, Colonia Dora, 15-26-XI-1979, C. M. Vardy (BMNH); 1 M, Termas de Rio Hondo, 17-XI-1951 (MLP). Catamarca: 1 M, San Antonio, 6-II-1958, R. Golbach (IML); 1 M, Lavalle, 26-IV-1951, A. Ogloblin (MLP). Cordoba: 1 F, (MACN); 1 M, 15-II-1945, on *Baccharis* (MLP). La Rioja: 2 F, 2 M, (AMNH); 4 M, La Rioja, Giacomelli (CU); 1 F, 1917 (CAS); 3 F, 2 M, same as holotype (MACN); 1 F, 6 M, Rio Salado, 4-V-1955 (MLP); 1 M, Illiar, I-1935, M. Gómez (KU); 1 F, 2 M, Villa Unión, 12-XII-1971, Porter and Stange (IML); 1 M, 7 km S Villa Casana, 10-XII-1971, Porter and Stange (IML); 1 M, Patquía, 22-II-1978, Willink and Dominguez (IML).

Doeringiella oblonga sp. nov.
(Fig. 63)

This species is known from the male sex only. It can be distinguished by T1 having extensive pale pubescence that encloses a central oval black area (hence the specific name), the preoccipital carina absent near the angle, the fringe on S5 as well developed as that on S3-S4. The penis with a lamella forming a projection unites *oblonga* with *burmeisteri* and *cingillata*. The description is based on the holotype, with measurements of the paratype in parentheses.

Male. Length 10.2 mm (10.3); length of forewing 7.5 mm (7.6). (a) Integument black, antenna wholly black (holotype), following parts light red: base of mandible, tegula, first flagellomere (paratype), pronotal lobe and legs beyond coxae. Wings slightly infuscated, with dark apical band; veins brown. (b) Face and venter of thorax with long, appressed white hairs; hairs other than maculations short, white on thorax and legs, dark brown on metasoma. Propodeum with appressed white hairs on posterolateral angles; sternal fringes pale. (c) Maculations cream-colored, of short, appressed hairs; pronotal band interrupted medially; notaular spots large, contiguous, elongate, as long as tegula; posterior scutal, scutellar, metanotal and mesepisternal bands complete; patch before tegula; T1 with extensive pale maculation that encloses central oval dark area; T2-T6 with broad apical band (on T4-T5 briefly interrupted medially in paratype). (d) Middle of mesepisternum with punctures 0.03-0.035 mm, interspaces thin. (e) Upper sculptured band of metapostnotum finely punctured, shorter than metanotum. Propodeum at sides of metapostnotum bare, no punctures. (g) Paraocular and supra-antennal areas forming continuous depression. (h) Frontal carina keeled, beginning half ocellar diameter below anterior ocellus, surpassing lower level of sockets. (i) Paraocular carina surpassing lower tangent of anterior ocellus. (j) Preoccipital carina obliterated near angle. (l) Labrum 0.55 times as long as wide (0.54); denticles separated by 0.33 times labral length (0.32); upper tubercles strong, prolonged apicad by carina. (n) Longitudinal impression of scutellum present; axilla triangular with blunt projection, outer side convex. (o) Supraspiracular carina concave, prolonged along posterolateral angle of propodeum as low ridge. (s) Length of vein r 0.65 times base of second submarginal cell (0.75). (u) Proportion of LID to UID 0.83 (0.81); AOD to IAD 0.44 (0.45). (v) Scape not swollen, 0.46 times UID (0.47); proportion of first and second flagellomeres together to scape 0.81 (0.82); subbasal angle present, section of plical surface on apical third flat. (w) Fringe on S5 with curled hairs that surpass posterior margin of sternite, as developed as fringes on S3-S4. (x) Middle femur with erect hairs on underside as long as apical width; hind femur with sparse, erect hairs. (y) Basal half of penis only partly sclerotized dorsally; lamella present, forming projection. Volsella present, hairy.

Material studied. Holotype male from *ARGENTINA:* Cordoba: Depto. Calamuchita, El Sauce, XII-1938, M. J. Viana (MACN); paratype male from Buenos Aires: Gonzalez Catán, II-1952, J. Foerster (KU).

Doeringiella paranensis sp. nov.
(Figs. 31, 48, 56)

This species is closely allied to *arechavaletai*. It is distinguished by the absence of a band on T1, the metasoma with pubescence other than maculations pale, the thorax and the face with extensive white hairs, the metanotal tuft pale, the preoccipital carina present behind ocelli, and the male scape as long as the basal 4.5 flagellomeres together. The name is from the biogeographic area where the species occurs. The description is based on the holotype, with measurements of the female paratype in parentheses.

Female. Length 16.5 mm (paratype 14.0); length of forewing 12.3 mm (10.5). (a) Integument black; center of mandible dark red; first flagellomere and legs beyond coxae brownish to black. Wings yellowish brown with dark apical band. (b) Hairs whitish, appressed around antennal sockets, short on clypeus and labrum, sparse on legs and thorax; hairs on metasoma other than maculations grayish, paler on sterna; metanotal tuft pale; long brown hairs on vertex, occipital region and propodeum, except a bunch of white hairs above supraspiracular carina. (c) Maculations on thorax of long, erect, whitish hairs partly intermixed with general pilosity; pronotal band

and notaular spots poorly defined; spot below pronotal lobe; posterior scutal band as lateral spot; maculations on metasoma of short appressed pale yellow hairs; T2-T4 with complete apical bands, no band on T1; T5 with hairs denser at sides. (d) Middle of mesepisternum with coarse punctures, diameter 0.05-0.06 mm, interspaces narrow. (e) Upper sculptured band of metapostnotum shorter than metanotum, rugose; longitudinal impression strong. Propodeum at sides of metapostnotum with strong punctures and hairs. (f) Proportion of LID to UID 0.81 (paratype 0.78); AOD to IAD 0.74 (0.74). (g-i) As in *arechavaletai*. (j) Upper sector of preoccipital carina distinct only behind ocelli. (l) Labrum 0.64 times as long as wide (0.66); upper tubercles moderate; apical denticles separated by 0.32 times labral length (0.35); apical point and longitudinal carina present. (m) Scape 0.47 times UID (0.44); proportion of first and second flagellomeres together to scape 0.70 (0.77); sub-basal angle weak; longitudinal keel limiting plical surface; section of plical surface on apical third concave. (n-q) As in *arechavaletai*, except pseudopygidial area 0.3 times as long as wide. (s) Length of vein r 0.85-1.0 times base of second submarginal cell.

Male. Length 13.0 mm; length of forewing 10.3 mm. (t) Color and vestiture similar to those of female, but white hairs on face and convex surface of scape; white hairs on thorax and legs denser; T2-T4 with yellow apical bands; sternal fringes brown. (u) Proportion of LID to UID 0.82; AOD to IAD 0.47. (v) Scape swollen, 0.62 times UID; as long as the basal 4.25 flagellomeres together; proportion of first and second flagellomeres together to scape 0.51; cavity wider than entrance hole. (w-y) As in *arechavaletai*.

Material studied. Holotype female, *ARGENTINA:* MISIONES: Pto. Bemberg (MACN). Paratypes, 1 F, 1 M, *BRAZIL:* SANTA CATARINA: Lagoa, Florianopolis, 1-XII-1959, P. D. Hurd Jr. (UFPR).

Doeringiella pilicornis sp. nov.
(Figs. 18, 40)

This species resembles *crinita* in coloration and size. It can be distinguished by the tuberculiform elevation between the antennal sockets (fig. 40), the preapical denticles of the labrum (fig. 18), the female S5 flat before the strongly bent apex and the erect hairs on the plical surface of the male scape (hence the specific name). The smallest specimens may be confused with *burmeisteri* and *chacoensis*, but the mesepisternal band, present in those species, is always absent in *pilicornis*.

Female. Length 7.4-10.2 mm (n = 3, m = 9.0, holotype 9.5); length of forewing 6.3-7.2 mm (n = 3, m = 6.6, holotype 6.3). (a-c) Coloration and vestiture as described for *crinita*, except scutellar and metanotal bands complete. (d) Middle of mesepisternum with close, small punctures, diameter 0.02-0.025 mm, some scattered wider intespaces present. (e) Upper sculptured band of metapostnotum as wide as metanotum, finely punctured; longitudinal impression weak. Propodeum at sides of metapostnotum bare, no punctures. (f) Proportion of LID to UID 0.7-0.72 (n = 3, m = 0.71, holotype 0.72); AOD to IAD 0.74-0.78 (n = 3, m = 0.76, holotype 0.75). (g) Paraocular and supra-antennal areas forming continuous shallow depression. (h) Frontal carina beginning one ocellar diameter below anterior ocellus, reaching lower level of antennal sockets; elevation between sockets with sides convex, tuberculiform. (i) Paraocular carina reaching lower tangent of anterior ocellus. (j) Preoccipital carina complete. (l) Labrum 0.53-0.58 times as long as wide (n = 3, m = 0.56, holotype 0.58); apical denticles before thick rim, separated by 0.26-0.28 times labral length (n = 3, m = 0.27, holotype 0.28); no upper tubercles. (m) Scape 0.36-0.41 times UID (n = 3, m = 0.38, holotype 0.41); proportion of first and second flagellomeres together to scape 1.0-1.09 (n = 3, m = 1.04, holotype 1.0); sub-basal angle weak, section of plical surface on apical third convex. (n-o) As in *crinita*. (p) S5 flat with perpendicular sides and apex bent down. (q) T5 with basal central area of denser hairs forming a patch. Pseudopygidial area as long as apical width, trapezoidal. (s) Length of vein r 0.6-0.7 times base of second submarginal cell.

Male. Length 7.8-8.7 mm (n = 2); length of forewing 6.2-6.4 mm. (t) Color and vestiture similar to those of female; T1-T6 with apical bands; in one specimen bands on T3-T5 interrupted medially. (u) Proportion of LID to UID 0.78-0.81; AOD to IAD 0.42. (v) Scape not swollen, 0.46-0.47 times UID; proportion of first and second flagellomeres together to scape 0.81-0.86; sub-basal angle strong; distal 2/3 of plical surface concave, with erect hairs as long as half apical diameter, opposite surface with appressed hairs. (w) Fringe on S5 of straight, sparse hairs that do not surpass posterior margin of sternum. (x) Middle femur with erect hairs on underside longer than apical width; hind femur with erect hairs. (y) Basal half of penis only partly sclerotized dorsally; lamella present. Volsella hairy.

Material studied. *ARGENTINA:* Holotype female, TUCUMAN, Los Puestos, Road to Rio Hondo, 8-IV-1967, Terán and Willink (IML). Paratypes: SALTA: 1 F, La Viña, II-1985, M. Fritz (MF). TUCUMAN: 1 M, same data as holotype (IML). CATAMARCA: 1 M, Campo de

Pucará, 23-I-1973, J. L. Neff (CTMI). La Rioja: 1 F, Huanchín, M. Gómez (MACN).

Doeringiella potrerillensis (Jensen-Haarup)
(Fig. 19)

Epeolus bifasciatus Jörgensen, 1909: 226. Lectotype female, by present designation, from Argentina, Mendoza, Potrerillos, 27-XII-1907 (MLP, examined). Jörgensen, 1912a: 141, 1912b: 315. Preoccupied name.

Epeolus potrerillensis Jensen-Haarup, 1909: 653. New name for *bifasciatus* Jörgensen, not *E. bifasciatus* Cresson, 1864. Jörgensen, 1912a: 634; Schrottky, 1913: 265.

Epeolus bicinctus Friese, 1925: 35. Holotype female, by monotypy, from Argentina, Mendoza, 27-XII (ZMB, examined). Synonymy by Moure, 1954: 275.

Doeringiella (Orfilana) potrerillensis: Moure, 1954: 274-275.

Females of *potrerillensis* may be confused with *baeri*; both species have the same color pattern of general deep black vestiture with white maculations. *D. potrerillensis* lacks the pronotal band and the notaular spots, the flagellum has the last 2-3 segments black, the apical denticles of the labrum are separated by 0.20-0.24 times the labral length (fig. 19) and the scape of the male is not swollen.

Female. Length 8.0-11.5 mm (n = 7, m = 10.2); length of forewing 8.2-9.8 mm (n = 7, m = 8.9). (a) Integument black; center of mandible, labrum in part and pronotal lobe dark red; scape, pedicel, basal 7-8 flagellomeres, tegula and legs beyond coxae light red. Wing membrane and veins yellowish brown on basal half, darker towards apex. (b) Labrum with sparse white hairs, remainder of head and thorax with appressed, brown hairs, intermixed with long, erect, black ones; legs with white pubescence; metasomal pubescence other than maculations black; propodeum with dense, long, black hairs. (c) Maculations (apical bands on T1 and T2 only) of short, appressed, white hairs. (d) Thorax with coarse punctures, diameter on middle of mesepisternum 0.035-0.055 mm, interspaces narrow. (e) Upper sculptured band on metapostnotum finely punctured, shorter than metanotum; longitudinal sulcus distinct. Propodeum at sides of metapostnotum with strong punctures and long hairs. (f) Proportion of LID to UID 0.70-0.76 (n = 7, m = 0.73); AOD to IAD 0.61-0.71 (n = 7, m = 0.67). (g) Paraocular area between antennal socket and upper ocular third moderately swollen. (h) Frontal carina beginning close to anterior ocellus, slightly surpassing lower level of antennal sockets; elevation between sockets with sides concave. (i) Paraocular carina ending just below lower tangent of anterior ocellus. (j) Preoccipital carina complete. (l) Labrum 0.60-0.68 times as long as wide (n = 7, m = 0.65); no upper tubercles; apical denticles separated by 0.18-0.24 times labral length (n = 7, m = 0.20); apical point present. (m) Scape 0.32-0.35 times UID (n = 7, m = 0.34); proportion of first and second flagellomeres together to scape 1.14-1.25 (n = 7, m = 1.19); sub-basal angle present; section of plical surface on apical third convex. (n) Longitudinal impression of scutellum weak; axilla triangular, produced as short tooth. (o) Supraspiracular carina strong, concave, prolonged along posterolateral angle of propodeum as low ridge. (p) Apex of S5 not bent down. (q) Base of T5 with short hairs denser on basal central area, but not forming a distinct patch. Pseudopygidial area as long as apical width. (s) Length of vein r 0.7-0.8 times base of second submarginal cell.

Male. Length 10-11 mm (n = 3, m = 10.7); length of forewing 9.2-9.8 mm (n = 3, m = 9.4). (t) White maculations more extensive than in female; pronotal band present, briefly interrupted medially; notaular spots united, forming continuous broad band; posterior scutal band as small lateral spot; patch on mesepisternum below pronotal lobe; hind coxa with dense patch; T1-T2 and T5-T6 with broad apical bands. Sternal fringes black. (u) Proportion of LID to UID 0.77-0.84 (n = 3, m = 0.80); AOD to IAD 0.40-0.43 (n = 3, m = 0.42). (v) Scape not swollen, 0.38-0.41 times UID (n = 3, m = 0.40); proportion of first and second flagellomeres together to scape 1.0-1.06 (n = 3, m = 1.03); subantennal angle strong, plical surface with erect hairs as long as half apical width of scape. (w) Fringe on S5 with long hairs surpassing posterior margin of sternum. (x) Underside of middle femur with erect hairs as long as apical width; hind femur with semiappressed hairs. (y) Basal half of penis only partly sclerotized dorsally; lamella present. Volsella hairy.

Material studied. ARGENTINA: Jujuy: 1 F, Rio Cincel, W of Abrapampa, 3500-3700 m, II-10-1970, L. Peña (AMNH); 4 F, 9 km S Humahuaca, XII-10-1975, R.M. Bohart (UCD). Salta: 1 M, Yacochuya, Cafayate, 1950 m, Willink, Terán and Stange, Malaise trap (IML). Tucuman: 1 M, Amaicha del Valle, 17-I-1968, Golbach, Terán and Willink (IML). Catamarca: 1 F, Minas Capillitas, desert scrub site, 23-XII-1973, J. L. Neff, on *Larrea divaricata* (CTMI). San Juan: 1 M, Leoncito, 25 km Calingasta, 2550 m, II-1966, Willink and Stange (IML). Mendoza: 1 F, Potrerillos, 27-XII-1907, lectotype of *D. potrerillensis* (MLP); 1 F, Mendoza, 27-XII, holotype of *E. bicinctus* (ZMB).

***Doeringiella similaris* sp. nov.**

This species is closely related to and sympatric with *simplicicornis*, but its range extends further southward to the province of Rio Negro. It is distinguished by the complete band on T2, the wings with dark apical band, the more extensive yellow hairs around the antennal sockets and minor differences in head proportions. The constancy of all these differences over a wide geographic range supports the recognition of *similaris* in spite of the lack of distinctive morphological features to separate it from *simplicicornis*. Males may be confused with *holmbergi*; see comments under that species.

Female. Length 8.5-12.0 mm (n = 8, m = 10.5, holotype 11.5); length of forewing 7.8-9.0 mm (n = 8, m = 8.6, holotype 8.5). (a-e) As in *simplicicornis* and *crassicornis*, but T1-T4 with complete apical bands, wings faintly infuscated with dark apical band. (f) Proportion of LID to UID 0.66-0.72 (n = 8, m = 0.69, holotype 0.66); AOD to IAD 0.57-0.63 (n = 8, m = 0.61, holotype 0.59). (g-j) As in *simplicicornis*. (l) Labrum 0.58-0.65 times as long as wide (n = 8, m = 0.62, holotype 0.60); upper tubercles present; apical denticles separated by 0.22-0.33 times labral length (n = 8, m = 0.27, holotype 0.33); apical point present. (m) Scape 0.36-0.37 times UID (n = 8, m = 0.366, holotype 0.37); proportion of first and second flagellomeres together to scape 1.0-1.14 (n = 8, m = 1.07, holotype 1.0); apical third of scape with plical surface flat to slightly concave. (n-s) As in *simplicicornis*, but hind basitarsus near base 1.3-1.5 times as wide as apex.

Male. Length 9.5-12.0 mm (n = 6, m = 10.3); length of forewing 8.1-8.7 mm (n = 6, m = 8.4). (t) Color and vestiture similar to those of female, T1-T6 with apical bands, on T5-T6 sometimes medially interrupted; sternal fringes pale. (u) Proportion of LID to UID 0.72-0.77 (n = 6, m = 0.75); AOD to IAD 0.38-0.45 (n = 6, m = 0.42). (v) Scape not swollen, similar to that of female, 0.40-0.45 times UID (n = 6, m = 0.42); proportion of first and second flagellomeres together to scape 0.90-0.97 (n = 6, m = 0.92). (w-y) As in *simplicicornis*.

Material studied. *ARGENTINA:* Holotype female, CORDOBA: El Sauce, Depto. Calamuchita, XII-1938, M. J. Viana (MACN). Paratypes: SALTA: 1 F, La Viña, III-1985, M. Fritz (MF); 1 M, 1 F, Rosario de Lerma, II-1983 and XII-1984, M. Fritz (MF); 1 F, Chicoana, XII-1985, M. Fritz (MF). TUCUMAN: 2 M, Tapia, 9-XI-1968 and 4-I-1976, A. Willink (IML); 1 F, 1 M, 15 km N Tucumán, I-7-1985, R. M. Bohart (UCD). CATAMARCA: 2 F, 6 km N Belén, 1240 m, 1-15-II-1969 (IML); 1 F, Andalgalá, 19-XI-1944 (MLP); 1 F, Andalgalá, 7-XII-1971, D. J. Brothers (KU); 1 M, Andalgalá, 8-III-1973, J. L. Neff, on *Grindelia pulchella* (CTMI); 1 M, Campo de Pocara, XI-11-1951, J. Foerster (KU). LA RIOJA: 1 F, Chilecito, 2-5-II-1977, A. Willink (IML). CORDOBA: 1 F, Giacomelli (MACN). SANTA FE: 1 F, Vera, 16-XI-1945, A. Ogloblin (MLP). RIO NEGRO: 2 M, Luis Beltrán, Fritz (MF); 1 F, 1 M, Darwin, XII-1984, M. Fritz (MF); 1 F, Lamarque, I-1985 (MF).

***Doeringiella simplicicornis* sp. nov.**
(Figs. 23, 28, 38, 58, 71)

This species and *similaris* look much like *crassicornis* in color, size and morphology. Females can be separated from *crassicornis* by the depressed paraocular area, the more parallel-sided hind basitarsus, reduction of the apical band on T2 to a lateral spot and the presence of bands on T3-T4. The male has the scape not swollen (the specific name refers to this condition).

Female. Length 9.8-12.2 mm (n = 8, m = 10.7, holotype 11.0); length of forewing 8.7-9.3 mm (n = 8, m = 9.1, holotype 9.0). (a) Integument black; center of mandible, labrum, scape, pedicel, pronotal lobe, tegula and legs beyond coxae dark red; first flagellomere and base of second light red. Wings evenly infuscated, veins dark brown. (b-e) As in *crassicornis*, but some pale hairs along preoccipital carina; notaular spots small, not extended posteriorly; T1 with complete apical band; T2 with apical band reduced to lateral spot; T3-T4 with apical bands complete or interrupted medially. (f) Proportion of LID to UID 0.69-0.72 (n = 8, m = 0.71, holotype 0.72); AOD to IAD 0.54-0.65 (n = 8, m = 0.58, holotype 0.54). (g) Paraocular and supra-antennal areas forming continuous distinct depression. (h) Frontal carina beginning immediately below anterior ocellus, ending in blunt sector surpassing lower level of antennal sockets; elevation between sockets with sides concave. (i) Paraocular carina ending above lower tangent of anterior ocellus. (j) Preoccipital carina distinct, complete. (l) Labrum 0.57-0.64 times as long as wide (n = 8, m = 0.61, holotype 0.58); upper tubercles present; apical denticles separated 0.28-0.38 times labral length (n = 8, m = 0.33, holotype 0.35); apical point present. (m) Scape 0.36-0.39 times UID (n = 8, m = 0.38, holotype 0.38); proportion of first and second flagellomeres together to scape 1.03-1.12 (n = 8, m = 1.05, holotype 1.03); apical third of scape with plical surface flat to slightly concave. (n-q) As in *crassicornis*, except pseudopygidial area 0.7-0.8 times as long as apical width. (r) Hind basitarsus near base 1.35-1.45 times as wide as

apex. (s) Length of vein r 0.8-1.0 times as long as base of second submarginal cell.

Male. Length 9.3-11.8 mm (n = 6, m = 10.8); length of forewing 8.8-10.0 mm (n = 6, m = 9.4). (t) Color and vestiture similar to those of female; T3-T6 with apical bands, sometimes not well developed; sternal fringes pale. (u) Proportion of LID to UID 0.78-0.81 (n = 6, m = 0.79); AOD to IAD 0.35-0.42 (n = 6, m = 0.38). (v) Scape not swollen, similar to that of female, 0.43-0.48 times UID (n = 6, m = 0.45); proportion of first and second flagellomeres together to scape 0.83-0.97 (n = 6, m = 0.89). (w) Fringe on S5 with straight hairs barely surpassing posterior margin of sternum. (x) Middle femur on underside with erect hairs nearly as long as apical width; hind femur with sparse erect hairs. (y) Dorsal edge of penis continuously sclerotized; without lamella. Volsella present, hairy.

Material studied. ARGENTINA: holotype female, Salta: La Viña, I-1984, M. Fritz (MACN). Paratypes: Salta: 2 F, 1 M, same data as holotype (MF, MACN); 3 F, La Viña, III-1985 and I-1987, M. Fritz (MF). Chaco: 1 M, Fuerte Esperanza, XI-1978, M. Fritz (MF). Santiago del Estero: 3 F, Los Tigres, 11-16-XI-1970, R. Golbach (IML); 1 M, Tintina, 21-II-1920 (CU). Catamarca: 1 M, Quebrada La Cébila, km 30, 16-I-1960, A. Willink (IML). La Rioja: 2 M, Illiar, 30-X-1928, M. Gómez (KU). Cordoba: 1 F, Giacomelli col. (MACN); 1 F, Yacanto, Depto. San Javier, I-1946, A. Bachmann (MACN).

Doeringiella singularis (Friese) comb. nov.
(Figs. 2, 6, 13, 33)

Epeolus singularis Friese, 1908: 87. Holotype female, by monotypy, from Argentina, Tucumán, 2000 m (ZMB, examined). Schrottky, 1913: 265.

Epeolus speciosus: Jörgensen, 1909: 219 (in part, misidentification).

Epeolus baeri: Jörgensen, 1912a: 140-141, 1912b: 315 (misidentification).

Doeringiella (Orfilana) martinezi Moure, 1954: 271-274. Lectotype female, by present designation, from Argentina, Buenos Aires, Dto. Puan, Felipe Sola, A. Martínez (UFPR, examined). **Synon. nov.**

There is only one female preserved in Berlin with Friese's original labels and indicated as type; it agrees with the original description except in size, it is 10.5 mm long instead of 9.5 mm as mentioned by Friese; I assume that this specimen is the holotype.

This species can be distinguished by its strong, laminate preoccipital carina, the propodeum around the metapostnotum with punctures bearing small hairs, the female S5 with the apex bent down, and the extensive cream-colored maculations over the whole body. The apical band on T1 is usually broadly expanded laterally; this is not the case in some specimens from Salta, Catamarca and La Rioja, but they agree in all other respects.

Female. Length 7.7-11.5 mm (n = 10, m = 9.4, holotype 10.5); length of forewing 6.0-8.5 mm (n = 10, m = 7.3, holotype 8.5). (a) Integument black except the following light reddish: labrum, mandibles, scape, pedicel, first flagellomere, pronotal lobe, tegula and most of legs except base of coxae. Wings hyaline with wide apical dark band. (b) Hairs around antennal sockets yellow; face, labrum and coxae with short, white hairs; vertex and occipital area with erect, brown hairs; metanotal tuft light brown, darker than maculations; posterolateral angles of propodeum, thorax and metasoma with vestiture other than maculations short, dark brown to black. (c) Maculations of short, appressed, white to cream-colored hairs; pronotal band complete; notaular spots united along median line forming single patch; posterior scutal band complete, briefly extended forward in middle; mesepisternal band as small spot below pronotal lobe and narrow band from scrobe to base of coxa; scutellar and metanotal bands complete; T1-T4 with apical bands, on T1 laterally expanded in holotype and most other specimens; T5 with lateral band. (d) Middle of mesepisternum with punctures 0.025-0.035 mm in diameter, separated by approximately one-fourth of those diameters, but also with some scattered wider interspaces; scutum and scutellum with similar punctation. (e) Metapostnotum with upper rugose band narrower than metanotum, finely sculptured. Propodeum at sides of metapostnotum with punctures bearing small hairs (fig. 2). (f) Proportion of LID to UID 0.68-0.73 (n = 10, m = 0.71, holotype 0.72); AOD to IAD 0.63-0.70 (n = 10, m = 0.66, holotype 0.64). (g) Supra-antennal and paraocular areas forming continuous depression. (h) Frontal carina keeled, sharp, beginning one ocellar diameter below anterior ocellus, barely surpassing lower level of antennal sockets; elevation between sockets with sides straight. (i) Paraocular carina reaching lower tangent of anterior ocellus. (j) Preoccipital carina distinct, complete, upper sector laminate, angle strong. (l) Labrum 0.54-0.66 times as long as wide (n = 10, m = 0.60, holotype 0.54), with central longitudinal impression; no tubercles or longitudinal carina; apical denticles separated by 0.21-0.40 times labral length (n = 10, m = 0.28, holotype 0.40); apical point small or absent. (m) Scape 0.34-0.37 times UID (n = 10, m = 0.35, holotype 0.34); proportion of first and second flagellomeres together to scape 1.09-1.16 (n = 10, m = 1.11, holotype 1.09). (n) Scutellum moderately bigibbous; axilla robust, briefly produced, outer side convex. (o) Spiracular carina strong, concave, continued along postero-lateral angle of propodeum. (p) S5 sharply bent up at sides, apex bent down. (q) T5 with short hairs denser on basal central area, not forming definite patch. Pseudopygidial area trapezoidal, 0.8-0.9 as long

as apical width. (s) Length of vein r 0.74-0.81 times base of second submarginal cell.

Male. Length 7.7-10.0 mm (n=6, m=9.0); length of forewing 6.8-8.4 mm (n=6, m=7.6). (t) Color and vestiture similar to those of female, face with silvery hairs, T1-T6 with apical bands, those on T4-T6 sometimes interrupted medially; sternal fringes pale. (u) Proportion of LID to UID 0.76-0.79 (n=6, m=0.78); AOD to IAD 0.45-0.48 (n=6, m=0.46). (v) Scape not swollen, similar to that of female, 0.39-0.42 times UID (n=6, m=0.41); proportion of first and second flagellomeres together to scape 0.88-1.0 (n=6, m=0.94). (w) Fringe on S5 with long hairs that surpass posterior margin of sternum. (x) Middle femur with erect hairs on underside shorter than apical width; hind femur with semi-appressed hairs on basal 1/3 to 2/3. (y) Basal half of penis only partly sclerotized dorsally; lamella present. Volsella hairy.

Material studied. ARGENTINA: SALTA: 2 F, Yacochuya, 9 km NW Cafayate, 23-26-IV-1970, Porter and Stange (IML); 1 M, Rosario de Lerma, XI-1984, M. Fritz (MF). TUCUMAN: 1 F, 2000 m, holotype of *singularis* (ZMB). CATAMARCA: 2 M, 6 km N Belén, 1240 m, 1-15-XII-1969, Malaise trap (IML). LA RIOJA: 1 M, San Francisco (MACN); 1 M, Patquía, III-1951, Martínez (UFPR). CORDOBA: 1 F, Depto. Calamuchita, El Sauce, XII-1938, M. J. Viana (MACN). MENDOZA: 1 F, Uspallata (MACN). LA PAMPA: 1 F, Salitral Levalle, 11-I-1968, L. Stange (IML); 2 F, 100 km N Rio Colorado, I-1985, M. Fritz (MF). BUENOS AIRES: 1 F lectotype and 2 M paralectotypes of *martinezi*, Felipe Sola, Dpto. Puan, A. Martínez (UFPR); 1 F, 12 M, Felipe Sola, Depto. Puan, XI-1951, XII-1951 and II-1952, A. Martínez (KU); 2 M, same data, III-1948 (MLP); 1 M, 30 km SW Villa Iris, 12-XI-1946, Martínez (MLP); 2 M, Tornquist, 500 m, XII-1954, F. H. Walz (KU). RIO NEGRO: 2 M, Norquincó, XI-1952 (KU); 1 M, Conesa, XII-1954, F. H. Walz (KU); 1 F, 4 M, Rio Colorado (MLP); 1 M, Rio Colorado, XI-1952 (KU); 1 M, Pomona, XII-1984, M. Fritz (MF); 5 F, Lamarque, I-1985, M. Fritz (MF); 1 F, San Antonio Oeste, Foerster (KU). NEUQUEN: 1 F, Zapala, III-1955, Foerster (KU).

Doeringiella speciosa (Friese)

Epeolus speciosus Friese, 1908: 84-85. Lectotype female, by present designation, from Argentina, Mendoza, 13-IV-1907, Jensen (ZMB, examined). Jensen-Haarup, 1908: 107; Jörgensen, 1909: 219 (in part), 1912a: 140, 1912b: 315; Schrottky, 1913: 265.
Doeringiella (Orfilana) speciosa: Moure, 1954: 271.

This species is readily distinguished by its red scutellum clothed with short, black hairs. It can be separated from the other two species with red scutella (*guttata* and *centuncula*) by the shape of the female pseudopygidial area (which is trapezoidal, similar to that of *singularis*, fig. 2), the complete preoccipital carina, the lateral spot on T5 of the female, the unswollen male scape and the white apical bands on T1-T6 of the male.

Female. Length 7.7-10.8 mm (n=9, m=9.5, lectotype 9.0); length of forewing 6.5-8.2 mm (n=9, m=7.2, lectotype 7.5). (a) Integument black except the following red: scape, pedicel, first flagellomere, tegula, scutellum, axilla in some specimens including lectotype, legs beyond trochanter. Wings weakly infuscated with wide, dark apical band. (b) Hairs on head, thorax and propodeum brown to black, including metanotal tuft; legs with short white hairs; metasoma with short pubescence other than maculations black. (c) Maculations of short, appressed, white hairs; pronotal band briefly interrupted medially, not covering pronotal lobes; notaular spots somewhat square, outer tip extended posteriorly; posterior scutal band reduced to lateral spot, no other maculations on thorax; T1 with apical band laterally expanded; T2 with apical band; T5 with lateral band. (d) Middle of mesepisternum with punctures 0.035-0.045 mm in diameter, confluent, interspaces narrow; punctures on scutum and scutellum smaller with wider interspaces. (e) Metapostnotum with upper rugose band narrower than metanotum. Propodeum at sides of metapostnotum without punctures, finely transversely striated. (f) Proportion of LID to UID 0.71-0.76 (n=9, m=0.73, lectotype 0.74); AOD to IAD 0.61-0.70 (n=9, m=0.68, lectotype 0.61). (g) Supra-antennal and paraocular areas forming continuous depression. (h) Frontal carina keeled, beginning half ocellar diameter below anterior ocellus, barely surpassing lower level of antennal sockets; elevation between sockets with sides straight. (i) Paraocular carina reaching lower tangent of anterior ocellus. (j) Preoccipital carina complete but not strong, angle low. (l) Labrum 0.56-0.62 times as long as wide (n=9, m=0.59, lectotype 0.62); no upper tubercles nor longitudinal carina; apical third bent forward; apical denticles separated by 0.21-0.28 times labral length (n=9, m=0.25, lectotype 0.28); small apical point present. (m) Scape 0.36-0.38 times UID (n=9, m=0.37, lectotype 0.37); proportion of first and second flagellomeres together to scape 1.08-1.17 (n=9, m=1.13, lectotype 1.17); sub-basal angle weak. (n) Scutellum moderately bigibbous; axilla triangular, shortly produced, outer side straight. (o) Spiracular carina short, restricted to top of spiracle. (p) S5 with apex bent down, ventral surface more or less flat and sides sharply bent up. (q) T5 with basal patch of hairs. Pseudopygidial area trapezoidal, 0.75-0.85 as long as apical width. (s) Length of vein r 0.60-0.65 times base of second submarginal cell.

Male. Length 9.5-12.5 mm (n=3, m=10.9); length of forewing 7.4-8.6 mm (n=3, m=7.9).

(t) Color and vestiture similar to those of female, but face with white hairs, T1-T6 with apical bands, sternal fringes black. (u) Proportion of LID to UID 0.76-0.81 (n = 3, m = 0.78); AOD to IAD 0.38-0.44 (n = 3, m = 0.42). (v) Scape not swollen, similar to that of female, 0.40-0.43 times UID (n = 3, m = 0.42); proportion of first and second flagellomeres together to scape 0.97-0.98 (n = 2); plical surface with erect hairs as long as half apical diameter of pedicel. (w) Fringe on S5 with long, apically curled hairs that surpass posterior margin of sternum. (x) Middle femur with erect hairs on underside shorter than apical width; hind femur with short appressed hairs on basal 1/2 to 2/3. (y) Basal half of penis only partly sclerotized dorsally; lamella present. Volsella present, hairy.

Material studied. ARGENTINA: La Rioja: 1 F, Jagüe, 9-III-1979 (IML). Córdoba: 1 F, El Sauce, Depto. Calamuchita, II-1953, M. J. Viana (MACN); 1 F, Cordoba (MACN); 1 F, 8 km La Cumbre, 26-II-1966, Willink and Weyrauch (IML). San Luis: 1 F, Potrero de Los Funes (MACN). Mendoza: 1 F lectotype, Mendoza, 13-IV-1907, Jensen (ZMB); 1 M, paralectotype, 18-IV-1905, on *Grindelia* (ZMB); 2 M, Cacheuta (MACN); Rio Negro: 1 F, 1 M, Rio Colorado, III-1958, A. Ogloblin (MLP); 2 F, Paso Flores, III-1963 (KU, MACN).

Doeringiella tricolor sp. nov.
(Fig. 61)

Doeringiella tricolor Moure, *in litteris* (labels on specimens, UFPR, KU).

This species is closely related to *gayi*. It may be recognized by its whitish maculations, the apical band on T1 transverse or slightly expanded laterally, the vestiture on the mesepisternum of short, appressed hairs and the flagellum mostly black. The two species are allopatric to a large extent, but both are recorded from the provinces of Neuquén and Chubut in Argentina. To judge by the localities, *tricolor* inhabits more xeric environments.

Female. Length 9.3-12.0 mm (n = 8, m = 10.3, holotype 9.5); length of forewing 7.0-9.0 mm (n = 8, m = 7.7, holotype 7.3). (a) Integument black; center of mandible, tegula and first flagellomere red; some specimens also red on pronotal lobe, part of labrum, scape and pedicel; legs vary from extensively blackish to light red beyond coxae (reddish beyond tibiae in holotype). Wings weakly infuscated with dark apical band. (b) Hairs on head mostly brown, sometimes white on outer side of antennal socket; legs and thorax with short hairs white to grayish; propodeum with hairs white to brown, along postero-lateral angles usually white; metasoma with hairs other than maculations dark brown on terga, grayish on sterna. (c) Maculations white, hairs semiappressed on thorax, short and appressed on metasoma; pronotal band interrupted medially; notaular spots slightly separated; posterior scutal and metanotal bands complete; scutellar band a central spot; a patch basal to tegula; mesepisternal band interrupted behind level of pronotal lobe; T1-T4 with apical bands complete or briefly interrupted; T1 in some specimens expanded laterally; T5 with band laterally. (d) Middle of mesepisternum with punctures 0.04-0.05 mm in diameter, interspaces 1/5 to 1/3 of those diameters, but some wider interspaces present. (e) Upper sculptured band of metapostnotum narrower than metanotum, punctured; longitudinal impression distinct. Propodeum at sides of metapostnotum with punctures and hairs. (f) Proportion of LID to UID 0.70-0.74 (n = 8, m = 0.72, holotype 0.70); AOD to IAD 0.52-0.62 (n = 8, m = 0.58, holotype 0.62). (g-j) As in *gayi*, except paraocular carina reaching lower tangent of anterior ocellus. (l) Labrum 0.60-0.65 times as long as wide (n = 8, m = 0.63, holotype 0.63); upper tubercles present, moderate; apical denticles separated by 0.26-0.35 times labral length (n = 8, m = 0.29, holotype 0.27). (m) Scape 0.32-0.37 times UID (n = 8, m = 0.35, holotype 0.34); subbasal angle weak; proportion of first and second flagellomeres together to scape 1.0-1.10 (n = 8, m = 1.06, holotype 1.07). (n-q) As in *gayi*. (s) Length of vein r 0.8-0.9 times base of second submarginal cell.

Male. Length 7.6-10.0 mm (n = 4, m = 9.1); length of forewing 7.6-8.2 mm (n = 4, m = 7.9). (t) Color and vestiture similar to those of female, but white hairs more extended, face wholly covered, notaular spots confluent with anterolateral patches of scutum; T1-T6 with apical bands, on T6 broadly interrupted; sternal fringes pale. (u) Proportion of LID to UID 0.78-0.80 (n = 4, m = 0.79); AOD to IAD 0.38-0.48 (n = 4, m = 0.43). (v) Scape not swollen, similar to female, 0.38-0.40 times UID (n = 4, m = 0.39); proportion of first and second flagellomeres together to scape 0.93-1.0 (n = 4, m = 0.96). (w-y) As in *gayi*.

Material studied. ARGENTINA: Holotype female, Chubut: Pingüinera, 30 km S Camarones, 18-I-1977, L. Stange (IML). Paratypes: Mendoza: 1 F, 1 M, 60 km S Bardas Blancas, 19-I-1975, Willink and Claps (IML); 1 F, above Uspallata, 1940 m, 6-XII-1979, C. and M. Vardy (BMNH); 1 F, Mina Aida, Depto. Las Heras, A. Stevenin (MACN). Buenos Aires: 2 F,

Tornquist, Sierra de La Ventana, 500 m, XII-1954, F.H. Walz (KU, UFPR). NEUQUEN: 1 F, Collón Curá, XII-1955, A. Giai (MACN). RIO NEGRO: 2 F, Lamarque, XII-1984, M. Fritz (MF); 1 M, Darwin, XII-1984, M. Fritz (MF). CHUBUT: 3 F, 1 M, same data as holotype (IML, KU); 1 F, Dique Florentino Ameghino, 31-I-1975, A. Willink (IML); 1 F, Puerto Pirámides, 14-I-1977, L. Stange (IML); 1 M, Península Valdez, Punta Norte, 15-I-1977, L. Stange (IML).

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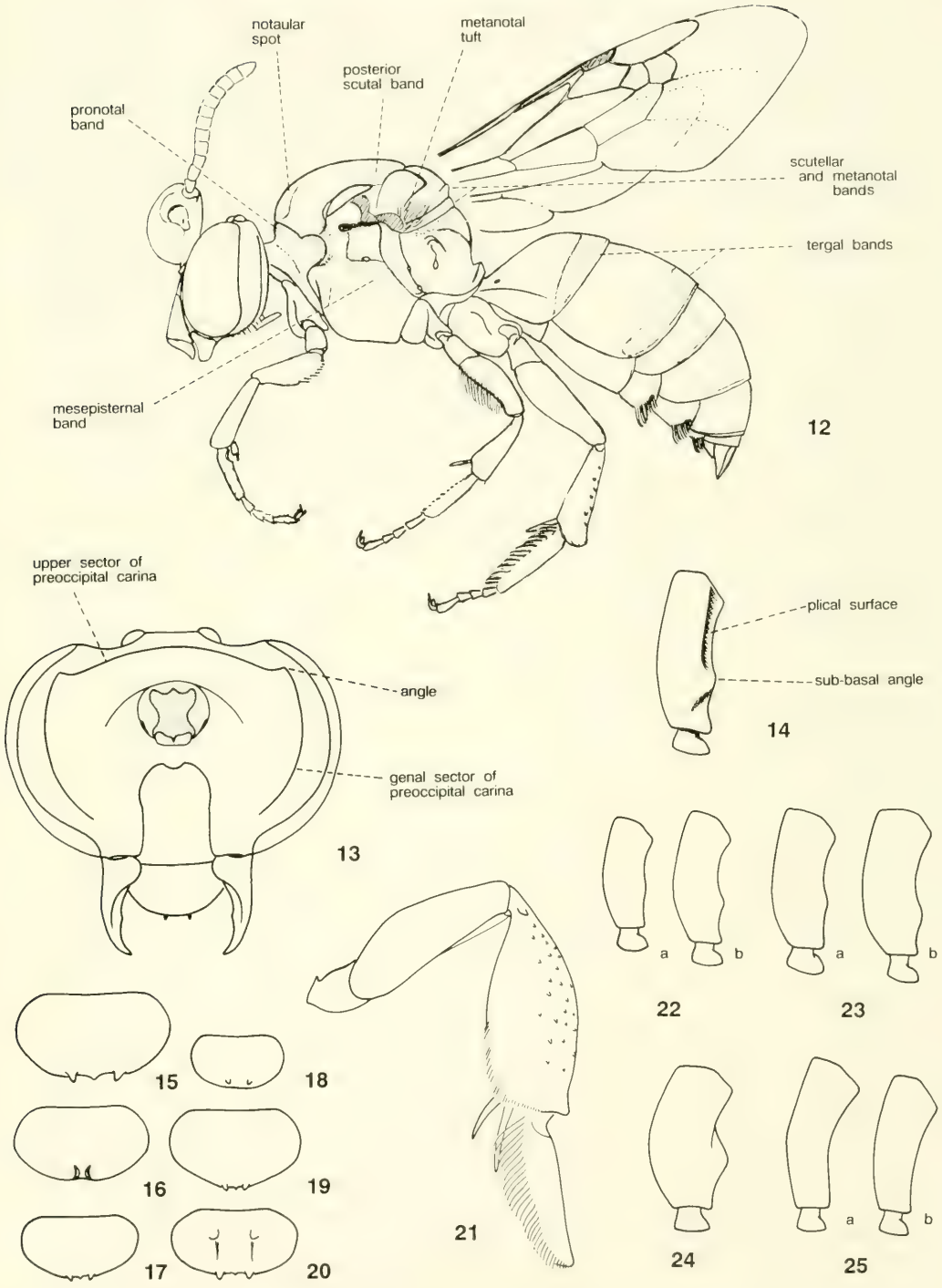
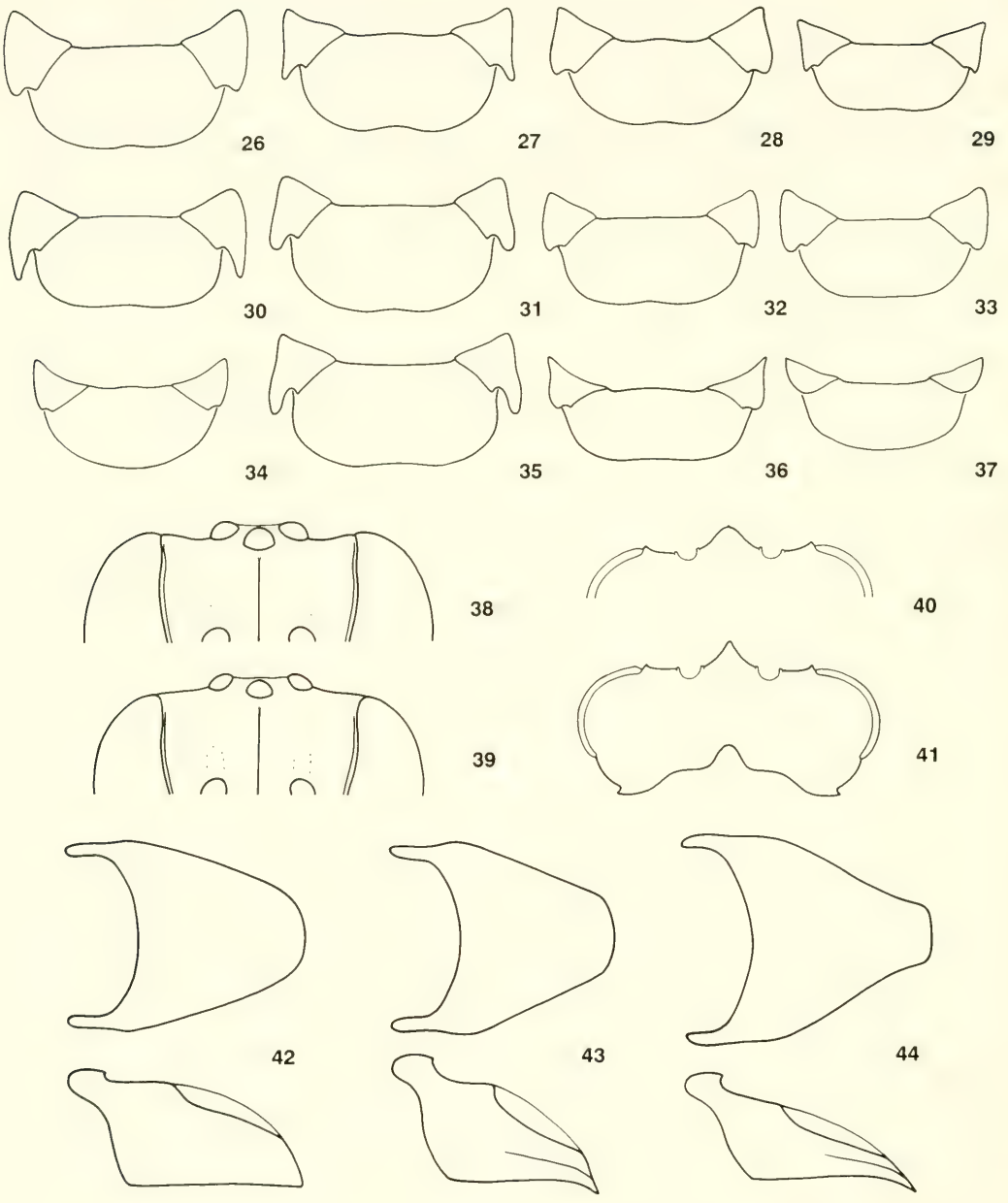


Figs. 12-25. 12, *Doeringiella bizonata*, maculation pattern. 13, *D. singularis*, posterior view of head. 14, *D. bipunctata*, scape of female. 15, *D. gigas*, labrum. 16, *D. baeri*, labrum. 17, *D. crinita*, labrum. 18, *D. pilicornis*, labrum. 19, *D. potrerillensis*, labrum. 20, *D. gayi*, labrum. 21, *D. crassipes*, posterior leg showing swollen tibia. 22, *D. guttata*; a, scape of female; b, scape of male. 23, *D. simplicicornis*; a, scape of female; b, scape of male. 24, *D. angulicornis*, scape of male. 25. *D. joergenseni*; a, scape of male; b, scape of female.



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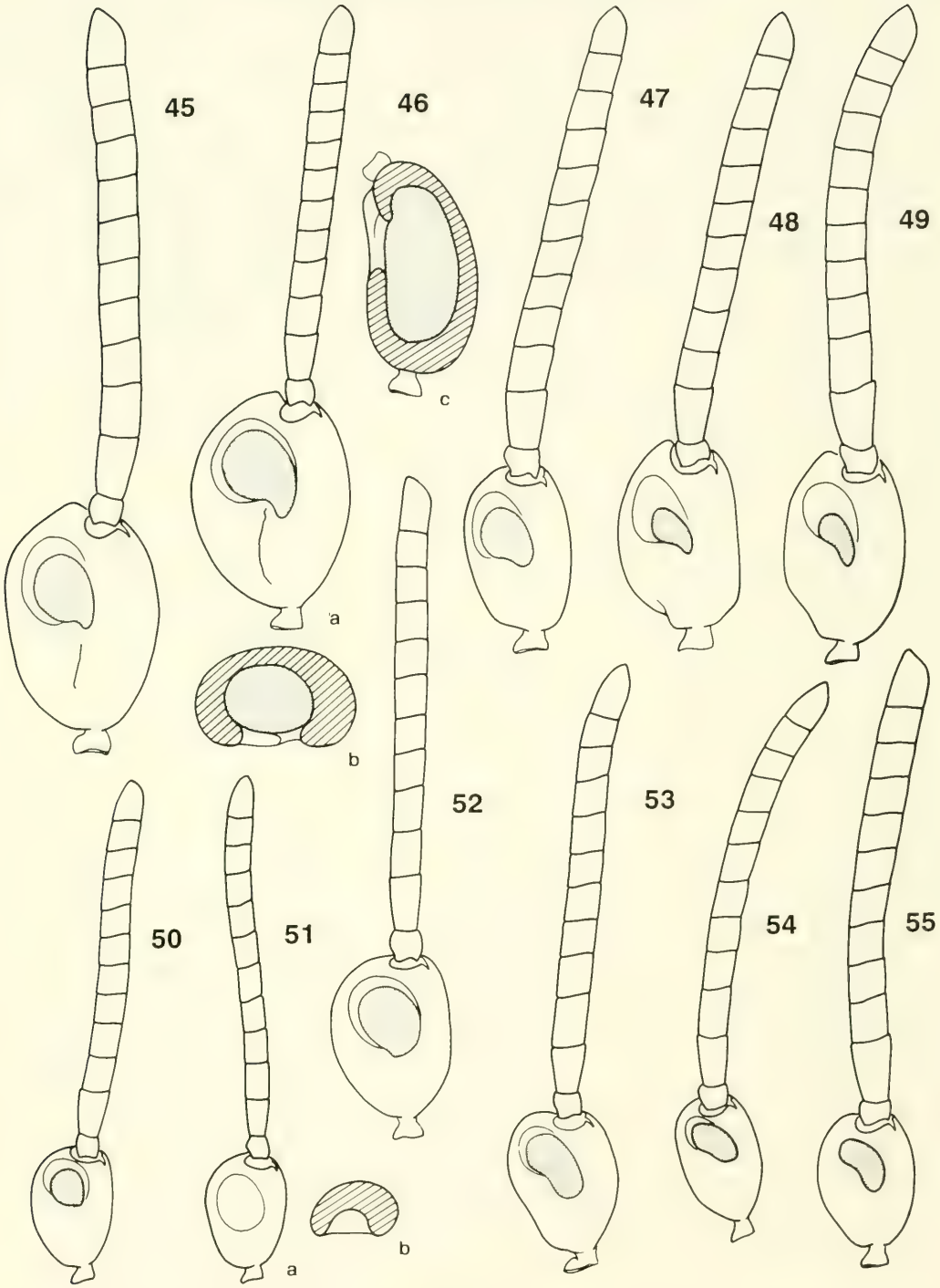

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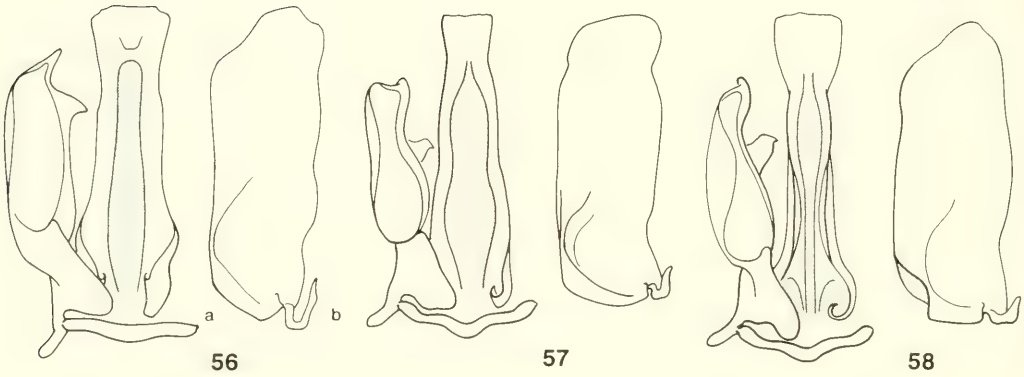

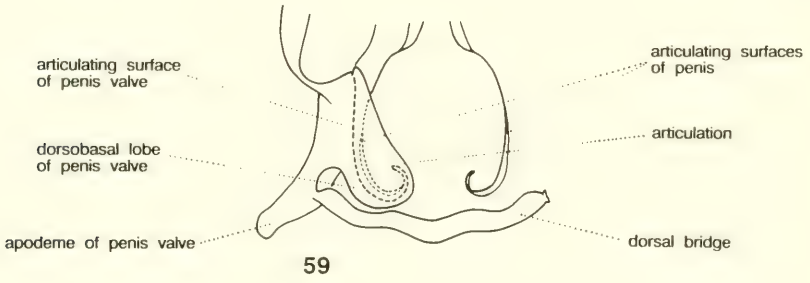

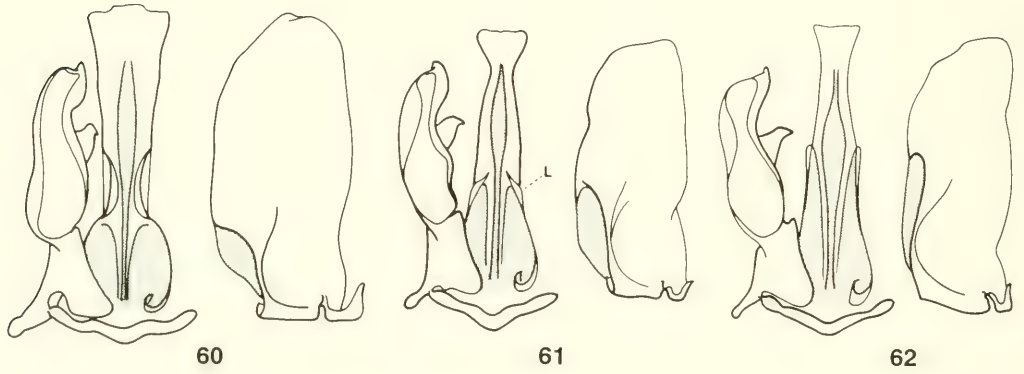

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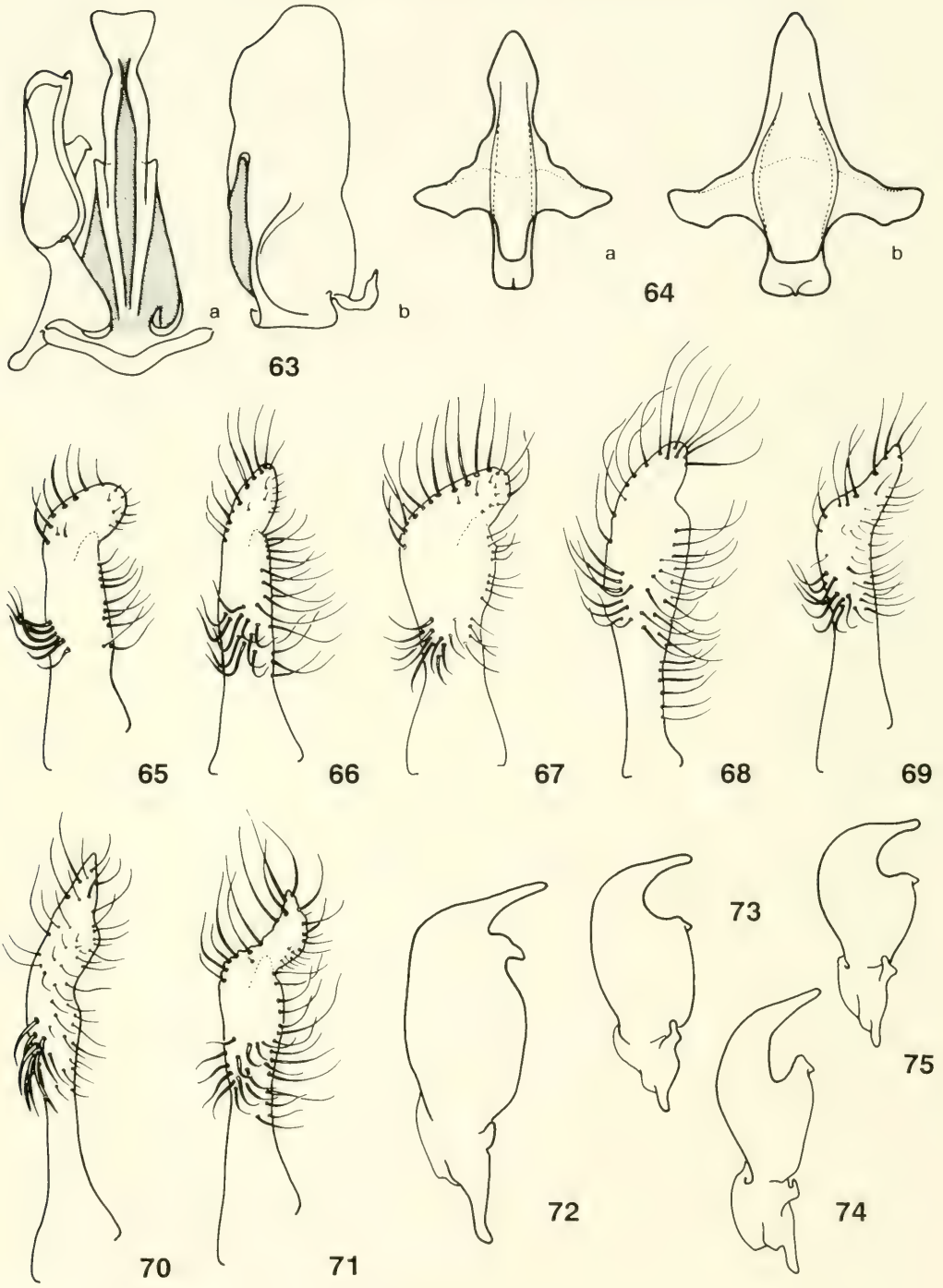

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Classification of American Colletinae (Hymenoptera, Apoidea)

By
Charles D. Michener

Vol. 53, No. 11, pp. 622-703 May 25, 1989

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Classification of American Colletinae (Hymenoptera, Apoidea)1

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ABSTRACT

The subfamily Colletinae consists of two tribes, the Paracolletini and the Colletini. The former, in the Western Hemisphere, is primarily limited to temperate climates in South America although one species reaches southern Arizona. The latter tribe is abundant in both North and South America although the most plesiomorphic genus is found only in temperate parts of South America. The treatment is to the genus and subgenus levels although numerous new species and taxonomic adjustments appear in the Appendix. The American genera of Paracolletini are *Leioproctus* (with 18 subgenera, 8 of them new), *Brachyglossula*, *Lonchorhyncha* new genus, *Niltonia*, *Eulonchopria* (with two subgenera, one new), and *Lonchopria* (with five subgenera, two new). The genera of Colletini are *Mourecotelles* (with three subgenera) and *Colletes*. Comparisons to the Australian paracolletine fauna are included and the Australian taxon *Phenacolletes* is raised to generic rank.

INTRODUCTION

This is a study to the genus and subgenus level of the Western Hemisphere species of the colletid subfamily Colletinae. The emphasis is on the Tribe Paracolletini because the status of the genera and subgenera within this group has been confusing. Unfortunately in some respects it remains confusing, but at least the nature of the problems is clarified. The other tribe, the Colletini, is treated in abbreviated fashion.

The terminology used is essentially that of Michener (1944, 1965). Terms for mandibles are from Michener and Fraser (1978); the only one used repeatedly is pollex for the upper marginal area that usually ends in a preapical tooth.

As in various groups of bees, the shape and dentition of the tibial spurs provides useful characters. Each spur has an inner and an outer margin, both on one surface of the spur. Following tradition, I have used the word *pectinate* for a spur margin with large, long teeth on it (e.g., Fig. 3f), even if only very few in number. A variant in which the large teeth are crowded together and arise from a slightly thickened part of the spur is called *palmate* (Fig. 24h), even though they do not actually arise from a common point. The word *ciliate* has been used in the past for spur margins with a row of numerous fine, slender, usually tapering and closely packed teeth (e.g., Fig. 3j). This term seems inappropriate considering its common use with reference to flexible, motile, cellular appendages. However, it is perfectly appropriate considering the original meaning for eye lashes, and current use for rows of hairs on leaf margins, etc. I have therefore retained the word. A spur margin with few, short, often angular teeth is called *serrate*; such spurs are rare in Paracolletini. Intergradations among these spur types are common and have to be explained or illustrated.

For ready comparisons among descriptions of genera, variables or groups of variables are numbered. Likewise for

comparisons among subgenera, variables are lettered in a pattern consistent within each genus.

Many structures are illustrated for taxa that have not before been illustrated. However, to save space and money, duplication of previously published illustrations has been avoided. References are included in the text to such previous illustrations.

Drawings are explained in the caption for Figure 2; other captions for drawings are abbreviated. Tibial spurs are illustrated with the more developed margin only (inner margin of inner hind spur, outer margin of outer hind spur).

To save space few taxa are described in full; others are described comparatively. For example, in the genus *Leioproctus*, the subgenus *Perditomorpha* is described independently; then other subgenera are described by telling how they differ from *Perditomorpha*, and more specifically, from the common characteristics, not those mentioned as exceptional, in the description of *Perditomorpha*.

The lists of species under each supraspecific taxon are not necessarily exhaustive. Some species are unplaced because I have not seen specimens. Some other species are placed only on the basis of literature; their names are marked by asterisks. When a species was originally described under a generic name different from the present genus or subgenus, the original generic name is indicated in square brackets after the author and date for the specific name.

For the methods used in cladistic analysis, see the section on Relationships among Paracolletine Bees.

For sources of borrowed material and a key to the institutions cited where types and other specimens are preserved, see the beginning of the Appendix.

SUBFAMILY COLLETINAE

This subfamily includes hairy colletids whose females have a scopa and whose body form is suggestive of *Halictus* or *Andrena*. Except for *Eulonchopria*, American genera either lack facial foveae or they are broad, shallow, and ill defined. Even in *Eulonchopria* they are not as narrow and sharply defined as in subfamilies like the Hylaeinae. The only other hairy colletids are in the Diphaglossinae (sense of Michener, 1986a). In the Colletinae the stigma is about as long as or longer than the prestigma, often well developed with the apex extending well beyond the point of union with vein r (Fig. 1a), although in the Colletini (Fig. 1b) and in the Australian genera *Paracolletes* and *Trichocolletes* the stigma is commonly reduced with vein r arising at or near its apex. In the Diphaglossinae, however, the stigma is shorter than the prestigma with vein r arising at its apex. In the Colletinae the glossa is shallowly bilobed, the lobes about as long as broad, or if deeply bifid the lobes extend distad and are slender throughout, the hairs not conspicuously branched. In Diphaglossinae the glossa is deeply bifid with the lobes broad basally, extending laterodistad, and with abundant, conspicuously branched hair.

As shown by Michener (1944), this subfamily can be divided into two tribes, as indicated below. The Colletini has various synapomorphies and is clearly holophyletic but the Paracolletini has no known synapomorphies; it is recognized by plesiomorphies. Presumably it is the paraphyletic group from which the Colletini evolved. At present I see no good reason to recognize the two tribes but will wait until completion of a planned study of higher categories of colletids before formally uniting the two by eliminating tribes in the subfamily Colletinae. Meanwhile no confusion results from continued use of the tribal names.

Key to the Tribes of Colletinae

1. Basitibial and pygidial plates present, at least in females (pygidial plate absent in most males; basitibial plate absent in a few Australian taxa); prepygidial and pygidial fimbriae of female present; S7 of male with apicolateral lobes of mod-

erate size (sometimes greatly reduced or absent), body of sternum and apodemes constituting major part of sternum. . . . . Paracolletini

—. Basitibial and pygidial plates absent; prepygidial and pygidial fimbriae absent so that vestiture of T5 and T6 is similar to that of preceding terga; S7 of male with apicolateral lobes greatly enlarged, body of sternum and apodemes reduced, slender, delicate, so that lobes are the major part of sternum. . . . Colletini

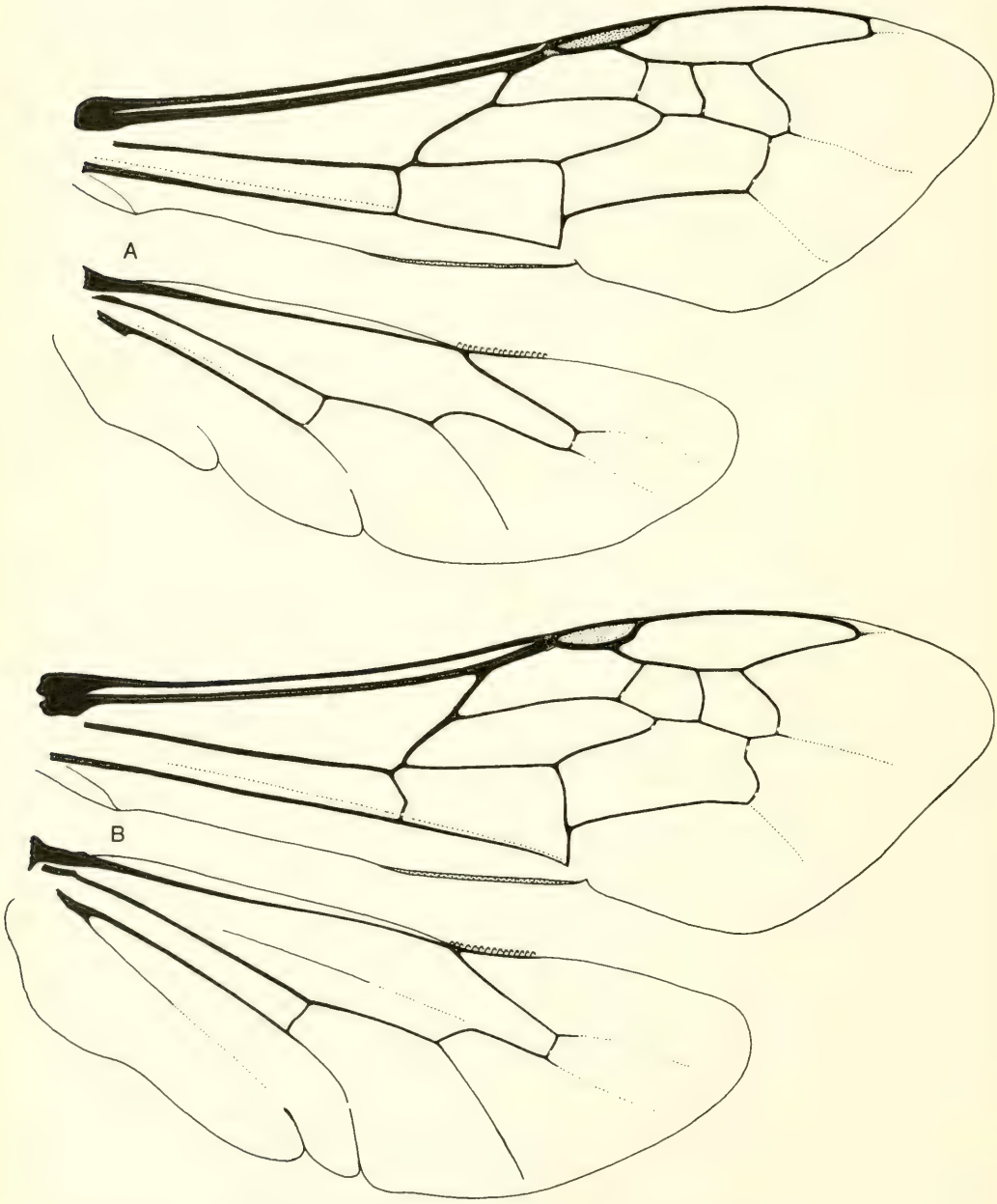

FIG. 1. Wings. **a.** *Lonchopria (Lonchopria) zonalis* (Reed). **b.** *Colletes inaequalis* Say.

TRIBE PARACOLLETINI

Paracolletine bees are abundant and diversified both in the Australian region and in temperate South America. The South African genus *Scrapter* is not among the genera here discussed. The Australian groups were reviewed by Michener (1965); the American groups are reviewed in the present work. In the following discussion only those Australian genera that are relevant to American groups are considered.

As noted by Michener (1986b), the tribal name that has priority for this group is Neopasiphaeini. However, I have requested that the International Commission on Zoological Nomenclature give precedence to the well established name based on *Paracolletes*.

Relationships among Paracolletine Bees

The group with the maximum number of plesiomorphies (as determined by comparison with outgroups such as the Andreninae) is the mostly Australian subgenus *Leioproctus* s. str. This is clearly a paraphyletic taxon consisting of the species that lack the apomorphies characteristic of other subgenera. I am not philosophically opposed to recognition of a paraphyletic group providing it is readily distinguished from other taxa. If a group of similar organisms is a useful unit, the discovery that a distinctive taxon was derived from it does not make it less useful. But one cannot defend *Leioproctus* s. str. in this way. The best one can say is that provisionally, recognition of *Leioproctus* s. str. is the practical solution to an uncomfortable problem.

A difficulty is that several of the subgenera derived from *Leioproctus* s. str. grade into it, as was pointed out for *Nodocolletes* and *Goniocolletes* by Michener (1965). Thus the justification for maintenance of a paraphyletic group is lost. But it is premature to decide what to do. There are some 120 specific names in *Leioproctus* s. str., many known from only one sex, and there are numerous undescribed species in the group. As collecting in Australia makes more species known, and especially makes known both sexes of more species, it should be possible to discover the relationships among species of *Leioproctus* s. str. and to develop a more satisfactory classification. Meanwhile, I provisionally recognize that subgenus in the sense of Michener (1965).

In a way the problem would be reduced by synonymizing *Nodocolletes*, *Goniocolletes*, and perhaps also *Microcolletes* and *Cladocerapis* under *Leioproctus* s. str. Yet most species in these groups are readily recognizable as different from *Leioproctus* s. str. and I leave such readjustments for the time when a thorough review of the genus in Australia is made.

One South American species, *L. fulvoniger*, falls within *Leioproctus* s. str. That is, it does not have apomorphies that seem to justify its separation as another subgenus. It is not closely similar to any Australian species and it differs from the great majority of them in having four instead of two apicolateral lobes on S7 of the male. In this respect, however, it resembles the Australian *L. advena* (Smith) and its relatives, which Michener (1965) notes might well be separated subgenerically from *Leioproctus* s. str., but in other features *L. fulvoniger* is quite different from *L. advena*. If *L. advena* and its relatives were separated subgenerically, probably *L. fulvoniger* should also be segregated. Two lobes is likely to be apomorphic since four is a widespread condition in other colletid subfamilies.

From the above, it is evident that paracolletine bees with numerous plesiomorphies (and without striking apomorphies relative to other paracolletines) occur both in the Australian region (including New Zealand) and in South America. Although only one American species is here placed in *Leioproctus* s. str., several other subgenera in South America are particularly similar to *Leioproctus* s. str. These include *Chilicolletes* and *Perditomorpha*.

In restudying the Australian subgenera of *Leioproctus*, I have been fortunate to see new material including the undescribed sexes of several previously described subgenera and species. I am impressed that except for those subgenera mentioned above, the subgenera seem quite distinct from *Leioproctus* s. str. although mostly probably derived from species that would be placed in that subgenus. The other subgenera also seem quite distinct

from American forms although some similarities are mentioned below.

I consider *Phenacolletes* to be a genus rather than a subgenus of *Leioproctus*. In addition to its striking characters listed by Michener (1965), the following may be noted: maxillary palpi short, only about as long as width of galea, four-segmented; basal vein of forewing basal to cu-v (as in another but quite different Australian genus, *Neopasiphae*); keirotrichia of female hind tibia short, forming a distinct band on inner surface. The first two are merely additional apomorphies of a remarkable bee. The short, distinctive keirotrichia, however, are common features of bees and wasps and probably plesiomorphic. Long keirotrichia, more like ordinary hairs, may be an apomorphy of *Leioproctus* and its derivatives. Thus *Phenocolletes* and *Leioproctus* could be sister groups.

American *Leioproctus*, like those of Australia, fall in numerous subgenera. A parsimony analysis of American paracolletine bees using PAUP version 2.2 (Swofford, 1984) was made with the assistance of R. W. Brooks, using 31 synapomorphic characters. (Program options were: adding sequence—closest; swap—global [mulpars]; root—two outgroups, one artificial, i.e., all plesiomorphic characters, the other, *Andrena*; weights—no differential weighting of characters; optimization—two sorts, one using Farris, the other Act.). Fifty equally parsimonious trees were produced using each of the optimization methods. Subsequent reruns were made omitting six variables that appeared four or more times on the tree and had consistency indices less than 0.25. Two other variables that appeared more than once in the tree and two taxa (*Chilicolletes* and *Protodiscelis*) were omitted one at a time to get an idea of the robustness of the tree. The number of "taxa" in the analysis was 33 including two outgroups and several species of *Biglossa* and *Perditomorpha*, each species treated as a separate taxon in the PAUP analysis.

After study of the results of the parsimony analysis, certain variables were recoded and the analysis re-run. Such *a posteriori* recoding was done only when a clear error in the original coding was revealed by the initial cladistic analysis.

The cladistic analysis emphasized the already evident numerous taxa here called the Basal Group or the Leioproctus Group. The included taxa are those placed in the genera *Leioproctus, Brachyglossula, Niltonia*, and *Lonchorhyncha*. These genera and the subgenera of *Leioproctus* have distinctive autapomorphies (omitted from the PAUP analysis), but the synapomorphies that might indicate cladistic relationships are few (only one or two at each step) and usually weak, appearing convergently in other parts of the study. All the cladograms have at least two effective trifurcations or quadrifurcations in the Basal Group. PAUP found different and equally parsimonious cladograms for this group. Omission of a taxon or a single variable caused major changes in these relationships. It follows that discovery of a new taxon or variable could have the same effect; within this group the results are anything but robust. I have no confidence in most of the relationships indicated and for the present regard the conservative cladogram for the Basal Group to be like a bush with 20 stems arising from a common base, their cladistic relationships unresolved.

Other than *Leioproctus*, those taxa accorded generic rank have numerous and conspicuous autapomorphies. Thus their recognition is on a phenetic basis. All may be derivatives of the Basal Group but could be its sister groups.

There are, however, several relationships within the Basal Group that seem robust, appearing repeatedly among the cladograms generated by PAUP. These are as follows:

The subgenera *Reedapis* and *Cephalocolletes* consistently appear as sisters. There is no doubt but that this is correct unless *Cephalocolletes* is derived from *Reedapis*. *Reedapis* does have its own autapomorphies, however. Thus one of the 20 stems is bifurcated.

The subgenera *Glossopasiphae* and *Tetraglossula* often appear as sister groups, partly because of the shared elongate, bifid glossa. I believe they are convergent in this feature, because of the great differences in labral shape, lateroapical labral lobes, male mandibular dentition, etc. The subgenus *Protodiscelis* appears as the sister group to *Glossopasiphae-Tetraglossula* or only of the lat-

ter. Its relationship to *Tetraglossula* appears to be phylogenetic, as indicated by three synapomorphies: labral shape, apicolateral labral angles, and simple mandibles of the male. Thus a second stem is bifurcate, showing the relationship of *Protodiscelis* and *Tetraglossula*.

The subgenus *Torocolletes* and the genus *Lonchorhyncha* appear consistently as sister groups. I do not believe that they are sisters, however, because of the strikingly different genitalic and sternal characters, autapomorphic for *Lonchorhyncha*, and because of the functional association and likely convergence of the characters that unite the two taxa. These taxa have slightly and greatly elongated malar areas, respectively, and associated with this feature, as in various other bees, the clypeus is elongate, shifted downward, and strongly convex and the labrum is less transverse (i.e., more elongate) than in most related bees. Redefining and recoding these variables could correct this problem. Presumably these characters are associated in providing space for an elongate proboscis, and could be considered a single character. However, in other parts of the tree the convex clypeus and less transverse labrum appear independently, and not associated with an elongate malar area. If these characters were regarded as a single feature to correct the problem with *Torocolletes* and *Lonchorhyncha*, useful information would be lost elsewhere in the study.

The subgenus *Spinolapis* and the genus *Niltonia* appear as sister groups, partly because the females share a ciliate or micropectinate inner hind tibial spur and a strong metasomal scopa. Again, I do not believe that these taxa are related, in part because of grossly different male genitalia and sterna, autapomorphic for *Niltonia*. The spur and scopal characters are weak, because they reappear at various places elsewhere in the cladogram. (There are seven changes of the spur variable and three of the scopal variable in the initial cladograms.)

In summary, the reliable aspects of the cladogram for the Basal Group consist only of lines for each taxon diverging from a common base, except that the subgenera *Reedapis* and *Cephalocolletes* are sister groups, as are *Protodiscelis* and *Tetraglossula*.

All the PAUP trees show, emerging from the Basal Group and usually as a sister group to *Leioproctus (Nomiocolletes)*, a substantial group including *Lonchopria* and its allies. It is here called the Lonchopria Group. Its synapomorphies include the lack of an apex of S8 of males that looks like a pygidial plate, and except for *Lonchopria (Lonchoprella)*, the distinctive features of the tibial scopa and hind basitarsus of the female as described below. Original PAUP trees showed *Eulonchopria* as the sister group to the rest of the Lonchopria Group. *A posteriori* recoding of the scopal variables resulted in placement of *Eulonchopria* at the very base of the Lonchopria Group, either as its sister group or sister group of *Leioproctus (Nomiocolletes)*, and for the present I place it as the most unusual member of the Basal Group. In any case, it is not reliably associated with the Lonchopria Group. So restricted, the Lonchopria Group consists of the genus *Lonchopria* only. The almost palmate inner hind tibial spur of the female (Fig. 24h) is a character of this genus.

Within *Lonchopria*, the subgenus *Lonchoprella* is the sister to all the rest. The subgenera *Lonchopria* s. str. and *Ctenocybne* together are the sister group to the subgenera *Biglossa* and *Porterapis* together

While it is reasonable to suppose that the Colletini (*Mourecotelles*) arose from somewhere in the Paracolletini, there is no good evidence as to which paracolletine genus is its sister group.

Trends in American and Australian Paracolletini

There are certain interesting similarities between American and Australian groups other than *Leioproctus* s. str. which is discussed above. The inner hind tibial spurs of females in *Leioproctus* and the related genera (*Brachyglossula, Eulonchopria, Lonchorhyncha*, and *Niltonia*; in Australia, *Phenacolletes, Neopasiphae, Paracolletes*) are coarsely pectinate to finely micropectinate or ciliate. In *Lonchopria*, however, they are almost palmate because the large teeth arise crowded together, from an often thickened region of the spur. Clearly this is an apomorphy. The Australian genus *Trichocolletes* has similar spurs, and its scopa

and hind basitarsus are also suggestive of those of *Lonchopria*. Note also the similarity in the male S8 between *Lonchopria (Ctenocybne)* and *Trichocolletes*. The reduced stigma of *Trichocolletes* (also *Paracolletes*), however, is an apomorphy unlike that of any American paracolletine.

In small size and general aspect, many species of the American subgenus *Perditomorpha* resemble those of the Australian subgenus *Microcolletes*. However, they are not closely related. *Perditomorpha* has two submarginal cells, and the propodeum has a distinct and rather long subhorizontal basal area, whereas *Microcolletes* has three submarginal cells and a largely or wholly declivous propodeal profile.

The Australian *Colletellus* is similar to the American *Perditomorpha*, agreeing in having two submarginal cells, a subhorizontal propodeal base, and numerous other characters. Both subgenera have short antennae although the flagellar segments of the male of *Colletellus* are shorter than in most *Perditomorpha*. I suspect that the similarities are convergent since *Colletellus*, like most Australian *Leioproctus*, has only two apicolateral lobes on T7 of the male while *Perditomorpha*, like most American species, has four (i.e., two on each side) or more.

In certain ways evolution in American and Australian *Leioproctus* has followed different paths. For example, reduction from three to two submarginal cells has been much more prevalent in America than in Australia. In America ten subgenera including *Perditomorpha*, the largest American group (about 45 named species), have two cells. The reduction must have occurred at least twice, for the subgenus *Sarocolletes*, which has apomorphies such that it could not be ancestral to other subgenera, has both two- and three-celled species. In the genus as a whole, two-celled species are much more numerous than three-celled species in South America. In Australia, however, there are only six two-celled subgenera, all very small except *Euryglossidia*, for species of which about 20 specific names have been proposed. Three-celled species are far more numerous than two-celled species in Australia.

Similarly, subgenera with the propodeal profile vertical or steeply slanting are numerous in Australia, although because of the many species in *Leioproctus* s. str., most Australian paracolletine species have a more or less horizontal basal propodeal zone. In America, however, nearly all subgenera have such a basal zone, although it is short, ill-defined, and sloping in various groups, especially *Nomiocolletes*.

A striking feature of diverse American taxa is the well developed sternal scopa of females, in addition to that on the hind legs. Many and possibly all Colletinae can be collected with abundant pollen sticking to the hairs of the sterna. However, in some taxa, such as *Leioproctus (Spinolapis)*, the sternal hairs are abundant and rather long, suggesting a scopa. In eight American taxa, not all closely related to one another although all are in the Basal Group, the sternal scopa is fully developed, often as conspicuous as in the Megachilidae and capable of carrying a large pollen load. The following taxa have a full sterna scopa: *Leioproctus (Glossopasiphae, Sarocolletes, Hoplocolletes, Tetraglossula, Reedapis, Cephalocolletes), Brachyglossula*, and *Niltonia*. Some species of *Leioproctus (Perditomorpha)* [e.g., *L. brunerii, arnauellus*, and *inconspicuus*] have a moderately well developed metasomal scopa.

BIOGEOGRAPHY

Given the unresolved nature of the cladistic analysis of American and Australian Paracolletini, a conclusive biogeographic analysis is not yet possible. Nonetheless some comments seem justified.

The presence on New Zealand of some species of *Leioproctus* s. str. not particularly different from Australian species suggests that these bees have crossed from Australia to New Zealand since these lands were in approximately their present positions. The distance is about 1900 km. It follows that, while the Paracolletini is undoubtedly an ancient group, it does not necessarily date from the time in the Cretaceous when Australia, Antarctica, and South America were in contact. It could have arisen much more recently and crossed water gaps of up to perhaps 2000 km between these continents to attain its present distribution.

The taxon with the greatest number of

plesiomorphies, *Leioproctus* s. str., is richly represented in the Australian region and occurs also in South America (one species). Even in the absence of groups defined by synapomorphies, this distribution suggests an origin in Australia and subsequent migration to South America where radiation occurred to produce the diverse American fauna, but where one species retained the attributes used to recognize *Leioproctus* s. str. Still present in the American fauna are other species but little divergent from *Leioproctus* s. str. (e.g., *Chilicolletes*) as well as those that have diverged greatly and are here recognized as generically different from *Leioproctus*. Of course ancestors of some such groups could have arrived independently in South America. To judge by morphological differentiation, the migration to South America, probably via Antarctica, long antedates the dispersal to New Zealand.

The Colletini (*Mourecotelles*-like bees) must have arisen from paracolletine ancestors in South America (possibly Antarctica), for Colletini do not exist in Australia. In the form of the derived genus *Colletes*, this tribe then spread to all continents except Australia.

Lonchopria has interesting apomorphic similarities (hind tibial spur of female, S8 of male, etc.) to the Australian *Trichocolletes*. In America there is a near intermediate between *Leioproctus* and *Lonchopria*, namely *Lonchopria* subgenus *Lonchoprella*. Thus it is likely that *Lonchopria* arose from a *Leioproctus*-like ancestor in South America. If the common characters exhibited by *Lonchopria* and *Trichocolletes* are homologous, then the ancestors of *Trichocolletes* may have migrated from South America to Australia via Antarctica. Given the prevalent westerly winds, such a migration is unlikely.

The reduced stigma characteristic of *Trichocolletes* is found also in the Australian genus *Paracolletes*, which is more like *Leioproctus* in other features. Such a stigma is apomorphic relative to the larger stigma of other Paracolletini. There is therefore the possibility that *Trichocolletes* is derived from *Paracolletes*-like ancestors and that the similarities of *Trichocolletes* to *Lonchopria* are convergent. Because a reduced stigma can be found in diverse large, fast flying bees, while the spur characters of *Trichocolletes* and *Lonchopria* are not found in other bees, it seems likely that the stigmal and related venational characters are convergent and that the spur indicates phyletic relationship.

Key to the American Genera of Paracolletini

1. Preoccipital carina strong, often lamella-like; pronotum dorsolaterally with strong transverse carina or lamella extending onto pronotal lobe; hind tibial hairs of female shorter than tibial diameter. . . . . *Eulonchopria*
—. Preoccipital and pronotal carinae (or lamellae) absent; many hind tibial hairs of female as long as or longer than tibial diameter. 2
2. Malar space nearly as long as or longer than eye (Fig. 23a-c); S8 of male weakly sclerotized, without apical process. . . . . *Lonchorhyncha*
—. Malar space little if any longer than flagellar width, usually virtually absent; S8 of male with strong median apical process. 3
3. Labial palpi enormous, 8-9 mm long, in repose reaching S3 or S4; claws deeply cleft, the two rami similar in shape and of almost equal length. . . . . *Niltonia*
—. Labial palpi ordinary; claws with inner ramus shorter than outer and differently shaped, at least in female, or rarely simple. 4
4. Forewing with three submarginal cells, second usually about as long as third on posterior margin (but see *Lonchopria* s. str., Figs. 1, 31h); apical process of S8 of male without flat apical region like a pygidial plate; inner hind tibial spur of female coarsely palmate-pectinate (Fig. 24h); tibial scopa except in subgenus *Lonchoprella* extremely dense, hiding tibial surface; hind basitarsus of female weakly concave on outer surface near upper margin, this surface very different looking from tibia, surface easily visible among hairs

usually shorter than those of inner surface. . . . . *Lonchopria*

—. Forewing with two submarginal cells or if with three, second much shorter than third on posterior margin (except in subgenus *Cephalocolletes* and most specimens of subgenus *Reedapis*); apical process of S8 of male with flat, bare apical region on upper side, looking superficially like a pygidial plate and usually exposed at apex of metasoma; inner hind tibial spur of female ciliate to coarsely pectinate, not at all palmate (Fig. 5f, g); female scopa not hiding tibial surface; hind basitarsus of female flat or convex on outer surface which is superficially similar to tibia and with hairs longer than those of inner surface (ignore hairs of upper margin). 5

5. Stigma small, vein r arising well beyond middle, costal margin of marginal cell 2.5-3.0 times as long as stigma; propodeum almost wholly declivous in profile; volsella of male large, vertically expanded, reaching dorsum of genital capsule, bifid; mandible of male tridentate. (Mid and both hind tibial spurs strongly curved and coarsely pectinate or outer hind spur of male sometimes dentate or almost simple; forewing with two submarginal cells.). . . . . *Brachyglossula*

—. Stigma elongate, vein r arising at or slightly beyond middle, costal margin of marginal cell 1.5-2.0 times as long as stigma; propodeum usually with subhorizontal or sloping basal part curving onto steeply declivous posterior surface; volsella more or less horizontal, ventral, not attaining dorsum of capsule; mandible of male simple or bidentate. (Tibial spurs not curved and coarsely pectinate, or if so, as in some *Reedapis*, then forewing with three submarginal cells.). . . . *Leioproctus*

Genus *Leioproctus* Smith

This large genus contains many subgenera and species and is found both in the Australian area and in South America. The most distinctive characters are italicized in the description below, and indicated in the key to genera. For a treatment of Australian subgenera, see Michener (1965).

Description: 1. Integument black, metallic blue or green, sometimes with the metasoma red; metasomal hair bands and colored integumental bands present or absent. Length 5-16 mm. 2. Face flat to moderately convex, supraclypeal area not much if any elevated above clypeus, frequently elevated above frons. Inner orbits converging to slightly diverging below. Malar space very short (in *Torocolletes* about as long as minimum flagellar diameter). Clypeus usually rather uniformly punctured, without or with only weakly evident upper median depressed, densely punctate area, or such area evident as in *Kylopasiphae* and a few species of *Perditomorpha*, often surrounded by extensive impunctate areas as in *Lonchopria*. 3. Facial fovea as in *Lonchopria* or slightly more clearly defined at upper end between ocelli and eye. 4. As in *Lonchopria*. 5. Mandible of females and most males with preapical tooth on upper margin; expansion or tooth on lower margin (as in many male *Lonchopria*) absent. 6. Labrum variable, *usually more than three times as wide as long*. 7. Proboscis variable as in *Lonchopria*; palpi also variable in length. 8. Male antennal flagellum variable in length. 9. Propodeum variable as in *Lonchopria* but dorsal surface sometimes longer than metanotum, subhorizontal, and up to two thirds as long as declivous surface in profile. 10. Front basitarsus of female usually without well formed comb of hairs on outer margin, but such a row of hairs present in subgenera *Cephalocolletes, Nomiocolletes, Reedapis*, and *Spinolapis*. 11. Inner hind tibial spur ciliate to coarsely pectinate, *bases of teeth in a uniform series, not crowded and diverging* from one another as in females of *Lonchopria*. 12. Femoral and tibial scopae variable, *tibial scopa not so dense as to completely obscure tibial surface*; hairs of inner surface of hind tibia moderately long, simple at least in a limited area, not forming zone of short keirotrichia. 13. Hind basitarsus of female slightly tapering but *apex more than half as wide as width near base; outer surface flat or convex, vestiture superficially rather similar to that of tibia, hairs longer than those of inner surface*. 14, 15. basitibial plate as described for *Lonchopria*, that of male always complete. 16. Wing vestiture variable; two or three submarginal cells, if three, second much shorter than third on posterior margin except in most specimens of *Reedapis* and *Cephalocolletes*; relation of basal vein and cu-v of forewing variable. Stigma moderate sized, costal margin of marginal cell 1.5 to 2.0 times as long as stigma, vein r arising at or slightly beyond middle, margin within marginal cell usually convex; apex of marginal cell as described for *Lonchopria*. 17. Jugal lobe variable in length. 18. Sternal scopa present or absent. 19. S6 and pygidial plate variable. 20-22. S7, S8, and genitalia of male variable. *S8 with apical process ending in rounded, beveled area that is exposed at rest and*

resembles a pygidial plate.

Distribution: This large genus occurs in Australia (north to New Guinea and Misool), New Caledonia, New Zealand, and temperate South America. *Leioproctus* s. str. occurs in the Australian area (see review by Michener, 1965), with a single species in South America.

Comments: In 1965 I used *Leioproctus* in a broad sense to include also the species here placed in the genera *Lonchopria* and *Brachyglossula*. Moure, however, in various papers cited below, recognized the groups that I place as subgenera at the generic level. I now feel that each of these arrangements fails to indicate relationships that are evident and I therefore have separated the three above-named taxa at the genus level. At the same time, I have included *Hexantheda* and *Tetraglossula*, hesitantly recognized at the genus level in 1965, in *Leioproctus*. So constituted, *Leioproctus* is a paraphyletic group from which *Lonchopria, Brachyglossula*, and probably the other American paracolletine genera, were derived in South America and *Neopasiphae, Paracolletes*, and *Trichocolletes* in Australia. *Leioproctus* is nonetheless definable and useful. Until more species are known and cladogeny better studied, especially in the diverse Australian fauna, there is no point in attempting to make a classification that mimics a cladogram, for there is no one correct or even generally acceptable cladogram and great instability would result.

KEY TO THE AMERICAN SUBGENERA OF LEIOPROCTUS

1. With three submarginal cells 2
—. With two submarginal cells 14
2. T1-4 in female and 1-5 in male with enamel-like apical margins, yellowish, green, blue or whitish in color, at least partly impunctate and hairless . . . . . *Nomiocolletes*
—. Terga with hairs and punctures near apical margins, which are not distinctively colored or are only translucent or brownish 3
3. Dorsolateral angle of pronotum produced as small tooth projecting upward and outward (smallest in male); basitibial plate of female not easily seen because its hairs are erect, similar to those of adjacent parts of tibia, and largely hiding marginal carinae . . . . . *Halictanthrena*
—. Dorsolateral angle of pronotum low, rounded, scarcely evident; basitibial plate of female distinct, hairs short, appressed, different from those of adjacent areas, marginal carinae clearly exposed. 4
4. Second submarginal cell on posterior margin usually at least three fourths as long as third; second transverse cubital vein usually curved in a manner parallel to third so that anterior margin of third submarginal cell is at least two thirds as long as posterior margin. 5
—. Second submarginal cell on posterior margin much shorter than third; second transverse cubital vein usually straight, at least not curved parallel to third; anterior margin of third submarginal cell usually less than two thirds as long as posterior margin. 6
5. Mandible of male with preapical tooth; outer hind tibial spur of female pectinate, although more finely so than inner spur; metasoma with at least weak blue reflections . . . . . *Reedapis*
—. Mandible of male simple; outer hind tibial spur of female coarsely ciliate; metasoma black. . . . *Cephalocolletes*
6. Thorax dull, minutely roughened, almost without punctures; malar area as long as minimum diameter of flagellum; clypeus protuberant in lateral view by fully eye width . . . . . *Torocolletes*
—. Thorax with at least some areas of shining integument between strong punctures; malar area linear; clypeus not or little protuberant 7
7. Males 8
—. Females 11
8. Subantennal suture little over half as long as diameter of antennal socket; supraclypeal and subantennal areas impunctate, shining, hairless, in contrast to adjacent areas . . . . . *Holmbergeria*
—. Subantennal suture as long as diameter of antennal socket; supraclypeal and subantennal areas punctate, with hairs. 9
9. Gonoforceps hairy to base; gonobase half as long as gonoforceps; apex of S6 with broad, shallow emargination; metasomal pubes-

cence all blackish. . . . . *Leioproctus* s. str.
—. Gonocoxite (or coxal part of gonoforceps) hairless; gonobase one third as long as gonoforceps or less; apex of S6 with the usual small, v-shaped (sometimes shallow) median emargination; metasoma with some or all hair pale, usually forming apical tergal bands. 10
10. Labrum three times as wide as long, apical margin broadly emarginate. . . . . *Chilicolletes*
—. Labrum little over twice as wide as long, apical margin convex or with small median emargination . . . . *Sarocolletes*
11. Inner hind tibial spur finely pectinate (almost ciliate) with over 25 teeth. . . . . *Leioproctus* s. str.
—. Inner hind tibial spur strongly pectinate with less than 10 teeth 12
12. S2-4 with apical bands of sparse, simple hairs not hiding surfaces of sterna. . . . . *Chilicolletes*
—. S2-4 with apical bands of long dense hairs forming a ventral scopa that partially hides surfaces of sterna 13
13. Tibial and sternal scopal hairs with numerous short, fine branches projecting laterally from rachis (as in Fig. 19e) . . . . . *Sarocolletes*
—. Tibial scopal hairs dividing to form few major branches; sternal scopal hairs simple . . . . . *Hoplocolletes*
14. Mandible of male simple; labrum about six times as wide as long, in female with apicolateral lobe bearing part of marginal fringe of bristles 15
—. Mandible of male with preapical tooth on upper margin, as in female; labrum two to five times as wide as long, without apicolateral lobe 16
15. Glossal lobes not much longer than basal width; scopal hairs of tibia and sterna with numerous short, fine branches; clypeal margin unmodified, truncate. . . . . *Protodiscelis*
—. Glossa deeply divided, lobes elongate, seven to ten times longer than basal width; scopal hairs of tibia and sterna simple or those of tibia with a few major branches; clypeal margin of male with short median lobe overhanging base of labrum. . . . *Tetraglossula*
16. Glossa deeply bifid, lobes about five times as long as basal width . . . . . *Glossopasiphae*
—. Glossal lobes short, not much longer than basal width 17
17. Labial palpus six- or seven-segmented, longer than maxillary palpus; hind tibia of male with strong carina from apex of basitibial plate to apex of tibia . . . . . *Hexantheda*
—. Labial palpus four-segmented, usually shorter than maxillary palpus; hind tibia of male without longitudinal carina, rarely with weak carina arising behind apex of basitibial plate. 18
18. S2-5 of female covered with short, unbranched, erect hairs that are enlarged and curved posteriorly at tips and of uniform length except longer on S2; pygidial plate of male defined, at least posterior end limited by carina; hind tarsus of male elongate, segment 2 well over three times as long as broad . . . . . *Pygopasiphae*
—. S2-5 of female with broad apical bands of relatively long, simple or branched hairs; T7 of male with pygidial area indicated only by lack of hairs (except large and somewhat defined in *Kylopasiphae*); hind tarsus of male not especially elongate, segment 2 less than three times as long as greatest breadth 19
19. Females 20
—. Males. 24
20. Tibial and sternal scopal hairs with numerous short, fine side branches projecting at right angles to rachis or curled basad . . . . . *Sarocolletes*
—. Tibial scopal hairs with long branches directed distad; sternum with hairs simple or with branches directed distad 21
21. Inner hind tibial spur coarsely pectinate with 10 teeth or less. 22
—. Inner hind tibial spur ciliate or finely pectinate with over a dozen teeth 23
22. Scopa of hind tibia formed around

tibia without long, loose hairs extending above and below; basitibial plate with carinate margins not hidden by hair. . . . . *Perditomorpha* (part)

—. Hind tibia with a few long, loose hairs fully half as long as tibia on upper and lower margins; basitibial plate hidden by hair except sometimes at base . . . . . *Kylopasiphae*

23. Inner hind tibial spur finely pectinate; claws simple or with inner ramus reduced to small tooth, shorter than basal diameter of outer ramus. Body metallic blue or greenish . . . . . *Spinolapis*

—. Inner hind tibial spur ciliate; inner ramus of claw strong, longer than basal diameter of outer ramus, so that claws are bifid. Body without metallic coloration . . . . . *Perditomorpha* (part)

24. T7 with shiny, hairless, irregularly rough pygidial area, not narrowed posteriorly, defined across posterior border by weak carina, this area occupying much of dorsum of tergum; S7 with apical lobes much reduced, in a single plane (Fig. 5e) . . . . . *Kylopasiphae*

—. T7 with dull or shiny, usually ill-defined pygidial area, sometimes a longitudinal strip, sometimes a broader area narrowed posteriorly; S7 with well developed apical lobes, two to four, usually at two levels, on each side. 25

25. Body metallic bluish or greenish; margin of S6 produced midapically as rounded hairy lobe about one third as wide as sternum, notched medially . . . . . *Spinolapis*

—. Body almost always nonmetallic; margin of S6 broadly rounded with median notch, often broad and shallow 26

26. Metasoma rather broad and flattened, resembling that of female in shape . . . . . *Sarocolletes*

—. Metasoma commonly rather slender, not flattened, usually distinctly different in shape from that of female . . . . . *Perditomorpha*

Subgenus *Perditomorpha* Ashmead

Perditomorpha Ashmead, 1899:86; Moure, 1954:165. Type species: *Perditomorpha brunerii* Ashmead, 1899 (monobasic).

Bicolletes Friese, 1908:11; Moure, 1954:170. Type species: *Bicolletes neotropica* Friese, 1908, by designation of Cockerell, 1915:342.

Edwynia Moure, 1951:195 (not Aldrich, 1930) (new synonym). Type species: *Pasiphae flavicornis* Spinola, 1851, by original designation.

Edwyniana Moure, 1954:165 (new name for *Edwynia*) (new synonym). Type species: *Pasiphae flavicornis* Spinola, 1851 (autobasic).

Belopria Moure, 1956:305 (new synonym). Type species: *Belopria zonata* Moure, 1956.

Leioproctus (Bicolletes, Belopria, Edwyniana and *Perditomorpha*); Michener, 1965:41.

This is the largest South American subgenus of *Leioproctus*. Because it is common, its characters are described in detail and other subgenera are mostly characterized by comparison to the usual (rather than exceptional) features of *Perditomorpha*. (Figs. 2, 3, 10a, b, e, 19a, b; Figs. 1-6, Moure, 1954; Figs. 1-3, Moure, 1956; Figs. 1- 6, Toro, 1968; Figs. 1-9, Toro and Rojas, 1970; Figs. 121-126, Toro, 1973b).

Description: a. Integument black, nonmetallic or sometimes with barely perceptible bluish tint, metasoma sometimes red (blue in a rather large, undescribed Argentine species). Length 5-13 mm. Pubescence all pale to all black, pale haired species usually with weak apical bands of pale hairs on terga. b. Inner orbits converging below. c. Clypeus usually rather uniformly punctured and hairy but sometimes largely hairless medially (as in male *L. ruber*) or nearly all smooth and shining (as in *L. stilborhinus*) or sometimes with lower and lateral parts sparsely punctate and shining, upper central part flat and closely punctate, suggesting *Lonchopria (Biglossa)* and its relatives (as in *L. mourei* and females of *L. herrerae, nitidior, flavicornis*, and weakly in *L. tristis*). d. Labrum of both sexes over three times as wide as long (often five times), apical margin straight, weakly convex, or weakly concave, apical bristles usually longer than labrum; nearly whole surface or at least basal two fifths forming elevated, convex bare zone so that distal depressed zone is usually narrow but sometimes wider than elevated basal zone; apicolateral lobe absent (illustrated by Toro, 1973b, for *L. flavitarsis*). e. Maxillary palpus usually long, about last three segments beyond apex of galea; in *L. iheringi* and *ruber* only one or two segments beyond apex of galea, and in *L. arnauellus, brunerii, chrysostomus, inconspicuus*, and *leucostomus* palpus scarcely attaining apex of galea. Mandible with preapical tooth on upper margin in both sexes (illustrated by Toro, 1973b, for *L. flavitarsis*). Glossa with lobes usually broader than long, sometimes about as broad as long. f. Ocelli near summit of vertex,

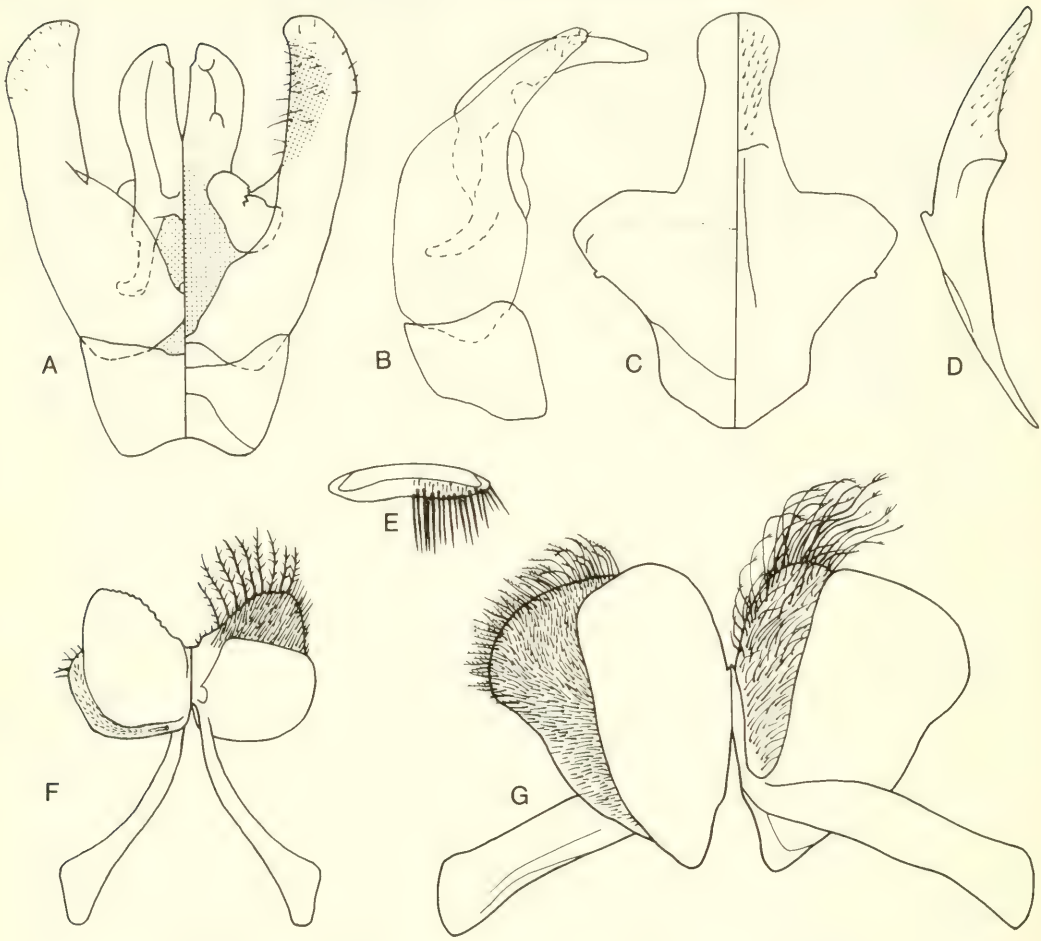

FIG. 2. **a-f.** *Leioproctus (Perditomorpha) eulonchopriodes* n. sp., male. **a, b.** Dorsal, ventral and lateral views of genitalia. **c, d.** Dorsal, ventral, and lateral views of S8. **e.** Labrum. **f.** Dorsal and ventral views of S7. **g.** *L. (P.) leucostomus* (Cockerell), dorsal and ventral views of S7.

anterior margin of median ocellus usually well behind midpoint between antennal bases and posterior edge of vertex but sometimes near that midpoint, at midpoint in *L. arnauellus* and female of *L. brunerii*. g. Male flagellum usually reaching tegula, sometimes as in *L. ruber* not attaining tegula; middle segments usually as broad as long or slightly longer than broad, sometimes broader than long as in *L. ruber* and *eulonchopriodes*, much broader than long in *L. arnauellus* and *brunerii*. h. Propodeum with subhorizontal surface usually shorter than but often longer than metanotum, steeply slanting and unusually short in *mourei, nitidior*, and *zonatus*; propodeal triangle smooth, less commonly weakly roughened or transversely wrinkled, marginal groove usually pitted but sometimes not. i. Anterior basitarsus of female without comb or row of hairs along outer margin. Basitibial plate defined by carinae, apex rounded (as in both sexes of *L. iheringi* and *zonatus*) to almost pointed. j. Femoral scopa sparse; hairs on anterior side of femoral corbicula with several long branches and no well marked rachis (except in *L. arnauellus, brunerii, inconspicuus*, and *leucostomus*, see discussion below), similar to hairs of outer side of tibia but smaller; on posterior side of corbicula hairs usually sparse and simple, sometimes a few branched as in *L. neotropicus* and *saltensis*, or less sparse and simple (*L. wagenknechti*), with plumose hairs near base (*L. herrerae*), or with branched hairs (*L. flavicornis, iheringi, nitidior, stilborhinus*, and *zonatus*), these hairs unusually long and dense in *L. nitidior* and *zonatus*. Tibial scopa sparse to well developed, white to black; long scopal hairs of lower margin of tibia curved upward, these and hairs of outer surface with long apical and preapical branches, several branches of each hair of more or less equal length, no axis extending far beyond branches (Fig. 19a) (except in *L. arnauellus, brunerii, inconspicuus*, and

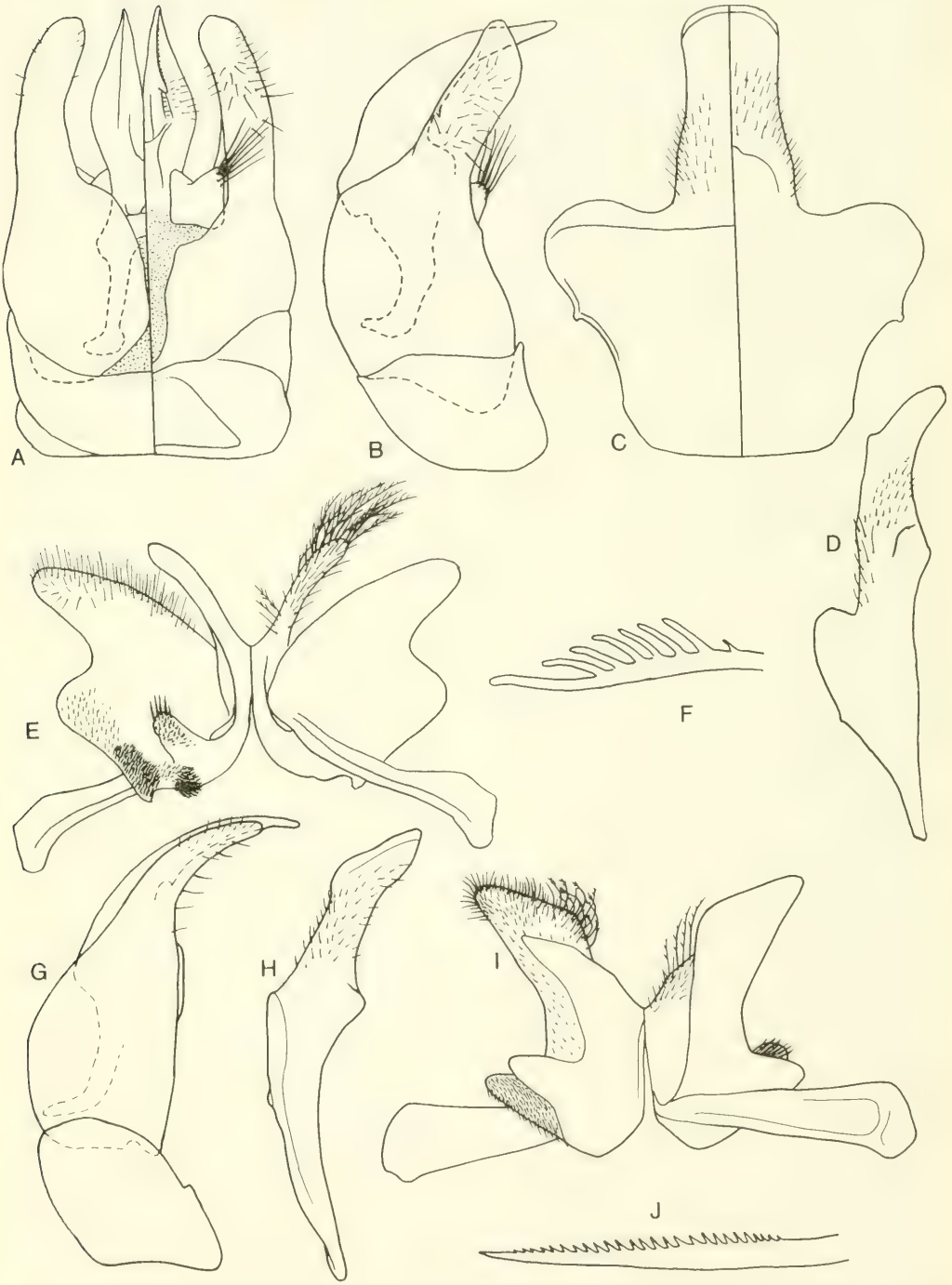

FIG. 3. **a-f.** *Leioproctus (Perditomorpha) inconspicuus* n. sp., male genitalia, S8 and S7; female inner hind tibial spur. **g-j.** *L. (P.) brunerii* (Ashmead), male genitalia and S8 (lateral views), S7; female inner hind tibial spur.

leucostomus, see discussion below). k. Tibial spurs straight, inner margin of inner spur of female pectinate (Fig. 3f), ciliate in *L. arnauellus* and *brunerii* (Fig. 3j), other margins ciliate (see illustration of *L. flavitarsis*, Toro, 1973b). l. Wings with minute hairs throughout or sometimes basal half or more hairless (as in *L. neotropicus* and *stilborhinus*); *two submarginal cells*, cell 2+3 subequal to 1; basal vein of forewing meeting or beyond cu-v; jugal lobe of hind wing usually reaching but sometimes not reaching or exceeding level of cu-v, in *L. neotropicus* and *stilborhinus* attaining midpoint between level of cu-v and apex of vannal lobe (as in *Kylopasiphae*). m. Sterna of female without well developed scopa but with apical bands of long hair (sometimes with pollen and functionally a scopa), hair suberect or sloping posteriorly, shorter than exposed parts of sterna, usually dense in band across posterior part of each sternum but sometimes sparse as in *L. flavitarsis* and *mourei*, usually simple or with only a few plumose hairs on median basal or on lateral part of each band, but sometimes coarsely branched as in *L. iheringi, saltensis*, and *neotropicus*; in *L. arnauellus, brunerii*, and *inconspicuum* sternal scopa moderately developed, hairs with numerous rather short side branches, mostly directed apicad. S6 of male unmodified, ordinarily with small apical emargination. Pygidial plate of male absent but T7 with median, often flattened, sparsely hairy or bare area (convex and bare, sharply different from adjacent areas, in *L. zonatus*). n. S7, S8, and genitalia of male as illustrated by Moure (1954), Toro and Rojas (1970) and for *L. zonatus* by Moure (1956) and *L. flavitarsis* by Toro (1973b), and in Figures 2 and 3 herein. Apicolateral lobes of S7 of the male two on each side, usually both broad and more or less rounded (Moure, 1954; Toro and Rojas, 1970; Toro, 1973b; Fig. 2f); lobes sometimes narrower and elongate, e.g. in *L. mourei* (Toro, 1968) and *zonatus* (Moure, 1956) or rather small and one somewhat elongate, e.g. *L. herrerae* (Toro, 1968), or broadened and extended basally, each bilobed so that there are four apicolateral lobes on each side in *arnauellus* and *brunerii* (Fig. 3). Process of S8 little downcurved; distal part of gonoforceps broad so that there is no stylus-like structure when viewed from above or below although slender distally in lateral view, under surface near apex with ill-defined membranous area.

Distribution: This large subgenus is abundant in temperate South America on both sides of the Andes and ranges north to Peru and the state of Ceará, Brazil.

Included species: (*marks species not seen by me): *Leioproctus (Perditomorpha) abdominis* Michener, 1965 (= *Pasiphae abdominalis* Jörgensen, 1912, preoccupied in *Leioproctus*); **alismatis* (Ducke, 1908) [*Panurginus*]; **andinus* (Herbst, 1923) [*Pasiphae*]; *arnauellus* Michener, named in the Appendix (= *Perditomorpha arnaui* Moure, 1954, preoccupied in *Leioproctus*); *atacama* Toro & Rojas, 1970; **basirufus* (Schrottky, 1920) [*Pasiphae*]; *bicellularis* (Ducke, 1910) [*Lonchopria*]; *brunerii* (Ashmead, 1899) [= *Pasiphae leaena* (Vachal, 1909)]; *chrysostomus* (Cockerell, 1917) [*Pasiphae*]; **coloratipes* (Cockerell, 1933) [*Pasiphae*]; **decoloratus* (Ducke, 1908) [*Panurginus*]; *erithrogaster* Toro & Rojas, 1970; *eulonchopriodes* Michener n. sp.; **fasciatus* (Schrottky, 1920) [*Pasiphae*]; **ferrugineus* (Moure, 1954) [*Bicolletes*]; *flavicornis* (Spinola, 1851) [*Pasiphae*]; *flavitarsus* Toro, 1973; **franki* (Friese, 1908) [*Bicolletes*]; **friesei* (Jörgensen, 1912) [*Pasiphae*]; *herrerae* Toro, 1968; *iheringi* (Schrottky, 1910) [*Pasiphae*] (= *Pasiphae cestri* Ducke, 1912); *inconspicuus* Michener n. sp.; *leucostomus* (Cockerell, 1917) [*Pasiphae*]; **longipes* (Jörgensen, 1912) [*Pasiphae*]; *lucidulus* (Cockerell, 1933) [*Pasiphae*]; **moerens* (Vachal, 1909) [*Pasiphae*]; *mourei* Toro, 1968; *neotropicus* (Friese, 1908) [*Bicolletes*]; *nitidior* (Moure, 1956) [*Belopria*]; **paraguayensis* (Schrottky, 1907) [*Perditomorpha*]; *penai* Toro & Rojas, 1970; *perezi* Toro & Rojas, 1970; *peruvianus* (Cockerell, 1926) [*Pasiphae*]; *pharcidodes* (Moure, 1954) [*Bicolletes*]; *pseudozonatus* (Moure, 1954) [*Bicolletes*]; *ruber* Toro & Rojas, 1970; *rufiventris* (Spinola, 1851) [*Pasiphae*]; *saltensis* (Friese, 1908) [*Bicolletes*]; **seydi* (Strand, 1910) [*Bicolletes*]; **spegazzinii* (Jörgensen, 1912) [*Calliopsis*]; **stictus* (Moure, 1954) [*Bicolletes*]; *stilborhinus* (Moure, 1954) [*Bicolletes*]; *tristis* (Spinola, 1851) [*Pasiphae*]; *wagenknechti* Toro & Rojas, 1970; *zonatus* (Moure, 1956) [*Belopria*].

Comments: In spite of the name of this subgenus, there is no resemblance to the panurgine genus *Perdita*. The following characters that are often of subgeneric or generic importance in bees vary within the subgenus:

Facial foveae of females are usually completely absent or represented only by areas that are less densely punctate or slightly more shiny than surrounding regions. However, the foveae are distinct, well defined, and depressed in females of *L. herrerae* and *tristis*.

Certain species are very coarsely punctate, unlike most species which are only moderately to finely punctate. One of the most coarsely punctate is *L. iheringi*. It also has the basal, subhorizontal part of the propodeum as seen in profile, slanting and unusually short, only about half as long as the metanotum, and the margin of the propodeal triangle marked by a row of strong pits. *L. eulonchopriodes* is similarly coarsely punctate, with yellow apical integumental bands on T1, 3, and 4, and with the apical tergal margins upturned and carinate as in *Eulonchopria psaenythioides*. *L. lucidulus* is intermediate in coarseness of punctation between *L. iheringi* and ordinary species.

Unusual features of certain other species are as follows: In *L. stilborhinus* the front tarsus of the

female is only about as long as the tibia, the basitarsus is particularly shortened, bristled apically, with a flat, hairless translucent apical process extending distad about to the apex of segment 3. In *L. neotropicus* (or a close relative) the lines margining the propodeal triangle are evanescent, so that the triangle, which is so clearly defined in most colletids, is often difficult to recognize. In *L. chrysostomus* the claws of each leg are asymmetrical, the principal ramus of the inner claw being enlarged and blunt.

The species that have been placed in *Edwyniana* are diverse. The type species, *L. flavicornis*, and *L. herrerae* are similar in being rather large, with strong apical bands of often erect white hair on T2-4, and with red legs. In these respects they differ from the other species placed in *Edwyniana, L. mourei* and *tristis*, which look like ordinary *Perditomorpha*. I can recognize no characters that justify separation of *Edwyniana* from the Bicolletes sort of *Perditomorpha*. Toro and Rojas (1970) already noted problems in the recognition of *Edwyniana*, some characters of *L. erithrogaster*, a rather ordinary looking *Perditomorpha*, being those attributed to *Edwyniana*.

The species that have been placed in *Belopria (L. zonatus, nitidior*) are slightly more distinctive and obviously closely related to one another. Both have the subhorizontal basal part of the propodeum steeply sloping and very short, so that the profile of the propodeum is almost wholly declivous. The same is true of *L. mourei* and is approached by *L. iheringi*. More noteworthy is the scopa which is better developed on the hind femora and trochanters than in any other *Perditomorpha*. Furthermore, the pygidial area of the male is represented by a convex bare area, narrowly rounded at the apex. Although not margined it is better developed than in other *Perditomorpha*. On the basis of these characters, *Belopria* could be recognized as a subgenus but it would be weakly differentiated compared to other subgenera and I have therefore chosen to place its species in *Perditomorpha*.

The subgenus *Perditomorpha* in the old sense contains only two previously described species (*L. arnauellus, brunerii*) that have long been separated from *Bicolletes* at the generic or subgeneric level (Moure, 1954; Michener, 1965). It no longer seems practical to maintain the distinction between *Bicolletes* and *Perditomorpha*, even at the subgeneric level. The following are the distinctive features of the two species listed above, lettered as in the subgeneric descriptions: g. Flagellum of both sexes very short, not over twice as long as scape, not attaining tegula, middle segments much broader than long. j. Scopal hairs on anterior side of femoral corbicula and on outer side of hind tibia plumose with branches along rachis (Fig. 19b). k. Margins of tibial spurs ciliate (Fig. 3j). m. Sternal hairs long, forming moderately distinct metasomal scopa, with numerous rather short, fine branches. n. S7 of male with lateroapical lobes large, each bilobed so that there are four lobes on each side, two of them extending far basally and two apically, apodemes extending laterally in opposite directions (Fig. 3i).

In the features listed above, *L. inconspicuus* agrees with *Perditomorpha* in the old sense except for the hind tibial spur (k) which is coarsely pectinate in the female, as in typical *Bicolletes* (Fig. 3f). Also the emargination between two of the lobes of S7 of the male is less deep, although the sternum is of the same type as that of *Perditomorpha* in the old sense (Fig. 3e).

L. leucostomus occupies a more clearly intermediate position between the old *Perditomorpha* and *Bicolletes*, and indeed has been placed at different times in each group. The scopal hairs of the hind leg (j) are like those of *Perditomorpha* in the old sense or those of the tibia with somewhat longer branches. The sternal scopa (m), however, is scarcely developed and the hairs are simple or with long branches, i.e., as in *Bicolletes*. The inner hind tibial spur of the female is pectinate but finely so, with about ten teeth, thus deviating from the ordinary coarsely pectinate type (with five or six teeth) in the direction of the old *Perditomorpha*. The flagellum of the male (g) is more elongate than in the old *Perditomorpha*. S7 of the male (n) has the two apicolateral lobes on each side large and extended basad but not divided into more lobes (Fig. 2g), thus intermediate between *Bicolletes* and the old *Perditomorpha*, but as in the latter, the apodemes extend laterally in opposite directions. *L. leucostomus* also differs from the old *Perditomorpha* in some less decisive characters (because they vary within *Bicolletes*) as follows: anterior ocellus well behind midpoint between antennal bases and posterior margin of vertex; basitibial plate rounded at apex, especially in female.

J. L. Neff (in litt.) has noted that *Perditomorpha* in the old sense (*L. arnauellus, brunerii*, and *inconspicuus*) seems to specialize in collecting pollen from Malvaceae, and the coarse pollen on specimens in collections supports this view. Specimens of *L. leucostomus*, however, have much finer pollen.

The correct position of *L. bicellularis* is in doubt although it is listed above as a *Perditomorpha*. It has strong apical enamel-like pale yellow bands on T1-4 of the female and T1-5 of the male, suggesting the subgenus *Nomiocolletes*, but does not resemble that subgenus in other features. Similar bands but on fewer terga are found on *L. (Perdito-*

morpha) eulonchopriodes, but the bands of *L. bicellularis* are flat and smooth, not upturned and carinate at the margins, and the body is not especially coarsely punctate as in *L. eulonchopriodes*. Features that do not agree with other *Perditomorpha* include the middle flagellar segments of the male which are fully 1.25 times as long as wide; the scopal hairs are as noted for *L. (P.) leucostomus* and *Perditomorpha* s. str. The claws of the female have the inner ramus reduced to a minute tooth so that they are almost simple; in the male the inner ramus is much smaller than usual. Unfortunately the only male of *L. bicellularis* seen [AMNH] lacks the apex of the metasoma so that the genitalia and hidden sterna remain unknown.

Chilicolletes new subgenus

Type species: *Leioproctus delahozii* Toro, 1973.

This subgenus closely resembles *Perditomorpha* but has three submarginal cells. It differs from *Sarocolletes* by the very different scopal hairs of the latter, and from American *Leioproctus* s. str. by the coarsely pectinate inner hind tibial spur of the female. (Figs. 4, 10c; Figs. 127-135, Toro, 1973b).

Description: Agreeing with usual (rather than exceptional) characters listed for *Perditomorpha* except as follows: a. Length 7-11 mm. Pubescence largely dusky, if with considerable pale hair, then usually with tergal hair bands. d. Labrum of male three times, of female over three times, as wide as long; apical margin gently concave (figures in Toro, 1973b). e. Maxillary palpus with about 2.5 segments beyond apex of galea. g. Male flagellum scarcely reaching tegula, middle segments slightly broader than long. h. Propodeum with subhorizontal zone about as long as metanotum; groove margining triangle weakly pitted or not pitted. i. Anterior basitarsus of female with weakly evident row of hairs along outer margin. j. Hairs along posterior margin of femoral corbicula with several short barbs. Hairs of tibial scopa with several long branches as in most *Perditomorpha* but with one (the rachis) distinctly longer than others. l. Wings with parts of basal cells hairless. *Three submarginal cells*, 2 much shorter than 3 and receiving first recurrent vein near middle or at distal end. m. Sternal scopa sparse, longer hairs almost as long as exposed part of sternum, simple or nearly so. T7 of male with large, bare, shining somewhat convex area, narrowed posteriorly, sharply defined by absence of hairs. n. S7, S8, and genitalia illustrated by Toro (1973b) and Fig. 4. S7 with apicolateral lobes elongate, unlike most *Perditomorpha*.

Distribution: Central Chile.

Included species: *Leioproctus (Chilicolletes) delahozii* Toro (1973) and at least one related undescribed species.

Comments: This subgenus is related to *Perditomorpha* and my first inclination was to include it in that subgenus in spite of the three submarginal cells. However, presence of a comb of hairs on the anterior basitarsus of the female is also unlike any *Perditomorpha*. This weakly developed comb, however, is not like that of *Nomiocolletes, Reedapis*, and *Cephalocolletes*. Instead it seems to be merely the abrupt line ending the vestiture of long hairs on the upper surface of the basitarsus, the lower

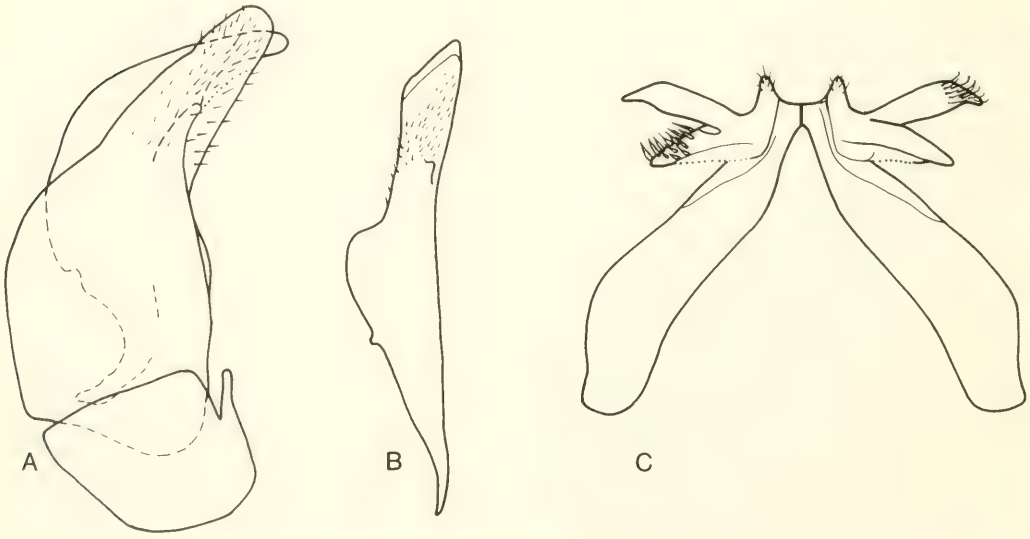

FIG. 4. **a-c.** *Leioproctus (Chilicolletes) delahozii* Toro, male, lateral views of genitalia and S8, dorsal and ventral views of S7.

surface being nearly bare, unlike other species. The other characters listed above are within the range of variation found in *Perditomorpha*. The trochanteral and femoral scopas are better developed than in most *Perditomorpha*. The presence of three submarginal cells suggests that this might be a surviving representative of the group from which *Perditomorpha* was derived. It cannot be a specialized derivative of *Perditomorpha* like the little groups here included in that subgenus, such as *Edwyniana, Belopria*, and *Perditomorpha* s. str.

Etymology: The subgeneric name is based on Chile, the country where these bees occur, and the generic name *Colletes*.

Kylopasiphae new subgenus

Type species: *Leioproctus (Kylopasiphae) pruinosus* new species.

This subgenus is similar to *Perditomorpha*. The greatly reduced lobes of S7 of the male are the most distinctive feature; others include the hidden basitibial plate and the features of the tibial scopa of the female (see below). The long antennae of the male also differentiate this subgenus from *Perditomorpha*; the short antenna of *Perditomorpha* is likely to be a derived feature uniting species of that subgenus. (Figs. 5a-f, 10f, 23e)

Description: Agreeing with usual (rather than exceptional) characters of *Perditomorpha* except as follows: a. Length 7-8.5 mm. Pubescence all pale, covering metasomal terga which lack apical hair bands or have weak bands in male. c. *Clypeus shiny and impunctate* except for lateral extremities and longitudinal median punctate depression; male with band of punctures across upper margin. d. Labrum about three times as wide as long; apical margin gently convex; basal two thirds shining, convex; female with transverse carina before depressed apical zone which lacks short hairs before apical fringe; longest apical bristles about as long as labrum in male, little longer in female; apicolateral lobe absent. g. *Male flagellum reaching beyond tegula, middle segments slightly over 1.5 times as long as broad.* h. Propodeum with subhorizontal surface 1.5 times as long as metanotum, not much sloping; propodeal triangle smooth, shining; marginal groove not conspicuously pitted, evanescent in female [as in *L. (Perditomorpha) neotropicus*]. i. *Basitibial plate of female small, hidden by hair* (even margin invisible without removing hair) except at base, that of male nearly hairless. j. Scopa rather dense. Hairs of trochanter and in front of femoral corbicula with several long branches directed apicad, most hairs with rachis exceeding branches (suggesting tibial scopal hairs of *Leioproctus* s. str., Fig. 19c). Hairs behind femoral corbicula abundant, mostly simple, a few branched ones near base of femur. Tibia on both lower and upper margins with a few extremely long (half as long as tibia or more), loose, hairs (Fig. 23e) with short branches directed apicad, these hairs extending as far below as above tibia; hairs on outer side of tibia like those of most *Perditomorpha* (Fig. 19a) but near margins grading through types like those illustrated for *Leioproctus* s. str. and *Perditomorpha* s. str. (Fig. 19b, c) to very long hairs; hairs of lower margin not strongly curved upward. l. Forewing almost hairless except for short hairs beyond venation and in distal part of marginal cell. Jugal lobe of hind wing extending to point half way between vein cu-v and apex of vannal lobe. n. *S7 of male with apical lobes greatly reduced*, not layered one above another but all on a single plane (Fig. 5e); S8 and genitalia as in Fig. 5a-d.

Distribution: Argentina, desert areas in the provinces of Tucumán, Catamarca, La Rioja, and Neuquén.

Included species: Leioproctus (Kylopasiphae) pruinosus Michener, n. sp.

Comments: This subgenus may be a derivative of some of the group of small species of *Perditomorpha* found in the same region. The relatively long jugal lobe of the hind wing suggests *L. (P.) neotropicus* and *stilborhinus*; the largely smooth female clypeus and supraclypeal area suggest the latter, and the near absence of the lines delimiting the propodeal triangle of the female suggest the former.

Etymology: The subgeneric name is based on the Greek *kylon*, face below the eyes, with reference to the shining clypeus, and *Pasiphae*, an unused generic name for Paracolletinae with two submarginal cells (see *Spinolapis*).

Subgenus *Leioproctus* Smith, s. str.

Leioproctus Smith, 1853:8; Michener, 1965:39. Type species: *Leioproctus imitatus* Smith, 1853, by designation of Cockerell, 1905a:348.

Lamprocolletes Smith, 1853:10. Type species: *Andrena chalybeata* Erickson, 1851, by designation of Cockerell, 1905a:344.

Dasycolletes Smith, 1853:14. Type species: *Dasycolletes metallicus* Smith, 1853, by designation of Cockerell, 1905a:347.

The comments and description below are based entirely on the single American species provisionally assigned to this subgenus and are not intended to encompass the variation exhibited by the many species in the Australian region. The three submarginal cells, the apical lobes of S7 of the male and the short, robust process of the male S8 are suggestive of *L. (Chilicolletes) delahozii*. The ciliate inner hind tibial spur, the longer male antennae, and other characters italicized below distinguish our species of *Leioproctus* s. str. from *Chilicolletes* and *Perditomorpha*. (Figs. 5g-l, 19c)

Description: Agreeing with usual (rather than exceptional) characters listed for *Perditomorpha*

except as follows: a. Length 10-11 mm. Pubescence largely dark but fulvous on dorsum of thorax; tergal hair bands absent. c. Clypeus with irregularly defined, narrow preapical zone shining and largely impunctate, especially in female. d. Labrum of both sexes four or more times as wide as long, apex gently convex, basal half elevated, convex, bare, shining, in male medially lower; depressed distal zone and distal slope of elevated zone with small hairs basal to fringe. g. Male flagellum reaching beyond tegula. h. Propodeum with subhorizontal surface a little shorter

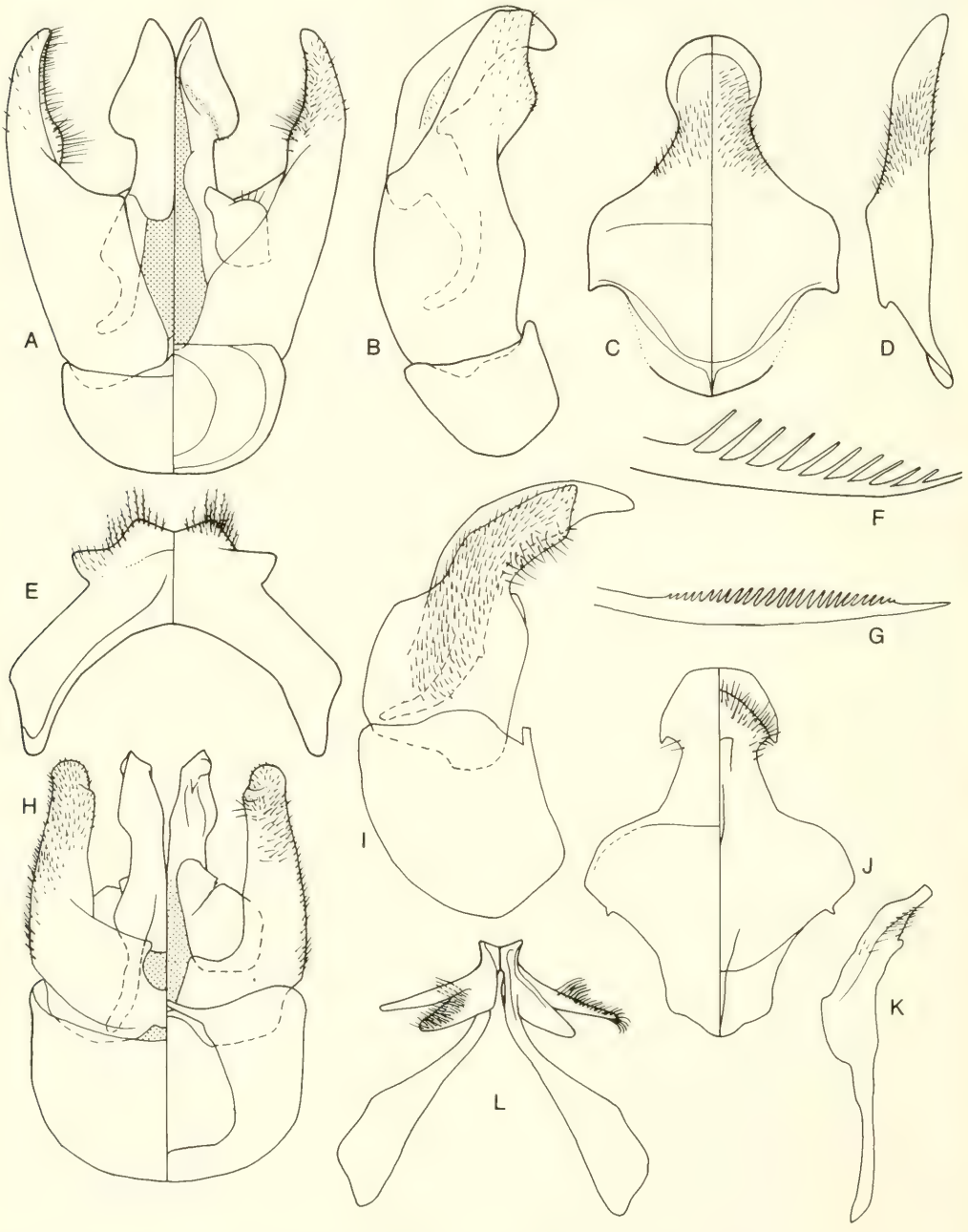

FIG. 5. **a-f.** *Leioproctus (Kylopasiphae) pruinosus* n. sp. Genitalia, S8 and S7 of male, inner hind tibial spur of female. **g-l.** *L. (Leioproctus) fulvoniger* n. sp. Inner hind tibial spur of female and genitalia, S8 and S7 of male.

than metanotum, sloping rather steeply; triangle dull, transversely striate; marginal line pitted especially anteriorly. i. Basitibial plate of female pointed, of male narrowly rounded. j. Hairs of femoral scopa black, rather short, straight, those on anterior side of corbicula with a few rather long branches diverging from rachis, thus similar to but smaller than tibial scopal hairs; on posterior side of corbicula hairs simple. Tibial scopa sparse, black, *long hairs of lower margin not much curved, thus scopa spreads as far below tibia as above it, branches of these hairs of moderate length, rather few in number, rachis of hair extending beyond branches* (Fig. 19c). k. *Margins of tibial spurs ciliate.* l. *Three submarginal cells*, 2 much shorter than 3 and receiving first recurrent vein beyond middle; basal vein distal to cu-v. m. Sterna of female with abundant hair sloping posteriorly, shorter than usual in *Perditomorpha*, not much over half length of exposed part of sternum. n. S7, S8, and genitalia as in Fig. 5h-l. Apical lobes of S7 rather slender, more or less as in *L. (Chilicolletes) delahozii*, not broad as in most *Perditomorpha*; S8 with apical process short and very robust; *gonobase enormous; gonocoxite with hairs nearly to base and with strong dorsal inner angle.*

Distribution: Santa Catarina, Brazil (and the Australian region).

Included species: *Leioproctus (Leioproctus) fulvoniger* Michener, n. sp., and about 120 species in the Australian region.

Glossopasiphae new subgenus

Type species: *Leioproctus (Glossopasiphae) plaumanni* new species.

The most distinctive character of this subgenus is the two long glossal lobes which resemble those of the subgenus *Tetraglossula*. However, the structure must have evolved independently, for *Tetraglossula* belongs with *Protodiscelis* in a group having simple mandibles in the male and an extremely short labrum with lateroapical lobes at least in females. *Glossopasiphae*, however, like many *Leioproctus*, has bidentate male mandibles and a relatively long labrum without lateroapical lobes. (Figs. 6, 19d)

Description: Agreeing with usual (rather than exceptional) characters of *Perditomorpha* except as follows: a: Length 12-14 mm. Pubescence largely black or dusky except for thoracic dorsum; tergal hair bands absent. b. *Inner orbits very slightly diverging below* (both sexes), *almost without concave region* so that upper parts of orbits are not greatly different in orientation from remainder. d. Labrum of male about twice as broad as long, of female over 2.5 times as broad as long; *apex produced to rounded angle*; male with basal two fifths gently convex, convexity slightly depressed medially; female with basal three fifths strongly elevated and convex; apical bristles scarcely longer than labrum; apical four fifths of labrum punctate, with hairs. e. *Glossa deeply bifid,* each lobe attenuate, hairy, about five times as long as basal width (Fig. 6h). Galea about as long as stipes, postpalpal part about six times as long as wide, not or slightly exceeded by maxillary palpus. f. Ocelli in front of summit of vertex; vertex convex and rounded behind ocelli; anterior margin of median ocellus in front of midpoint between antennal bases and posterior margin of vertex. g. Male flagellum not attaining tegula, middle flagellar segments slightly broader than long. h. Propodeum with basal zone steeply sloping in profile, shorter than metanotum; propodeal triangle transversely striate granulate, marginal groove not pitted. i. Basitibial plate rounded at apex, narrowly so in male. j. Femoral corbicula with a few short hairs on surface basally; scopa on anterior side of corbicula long, dense, hairs with many fine, short lateral branches as on tibial scopa; trochanteral hairs similar; hairs on posterior side of corbicula simple or toward base of femur with fine, short side branches. Tibial scopa dense, long, extending farther below tibia than above, hairs of lower margin gently curved apicad and slightly upward; *hairs with many fine, short branches at more or less right angles to rachis and often curved basad* (Fig. 19d), *rachis extending well beyond branches*. k. Tibial spurs gently curved near apices, *inner hind spur of female coarsely pectinate*, other margins coarsely ciliate. l. Basal vein of forewing meeting cu-v. m. *S2-5 of female with dense scopa* of hairs as long as exposed part of sternum, similar to those of tibial scopa. n. S7, S8, and genitalia of male as in Fig. 6. S8 with apical process not bent down, without ventral tubercle. Gonostylus fused to gonocoxite, with distal ventral membranous area.

Distribution: Santa Catarina, Brazil.

Included species: Leioproctus (Glossopasiphae) plaumanni Michener, n. sp.

Etymology: The subgeneric name is based on the Greek *glossa*, tongue, with reference to the elongate glossa, plus *Pasiphae*, a generic name used for various paracolletines with two submarginal cells (see *Spinolapis*).

Sarocolletes new subgenus

Type species: *Lonchopria rufipennis* Cockerell, 1917.

The appearance of the scopal hairs, with numerous short fine side branches, is a striking feature of this subgenus shared only with *Glossopasiphae* and *Protodiscelis*. Most other characters agree with those of *Chilicolletes*, or in the case of two-celled species, with *Perditomorpha*. *Sarocolletes* differs further from those subgenera, however, in the well developed ventral scopa of the female and in the relatively broad metasoma of the male which therefore resembles a female. (Figs. 7a-h, 10g)

Description: Agreeing with usual (rather than

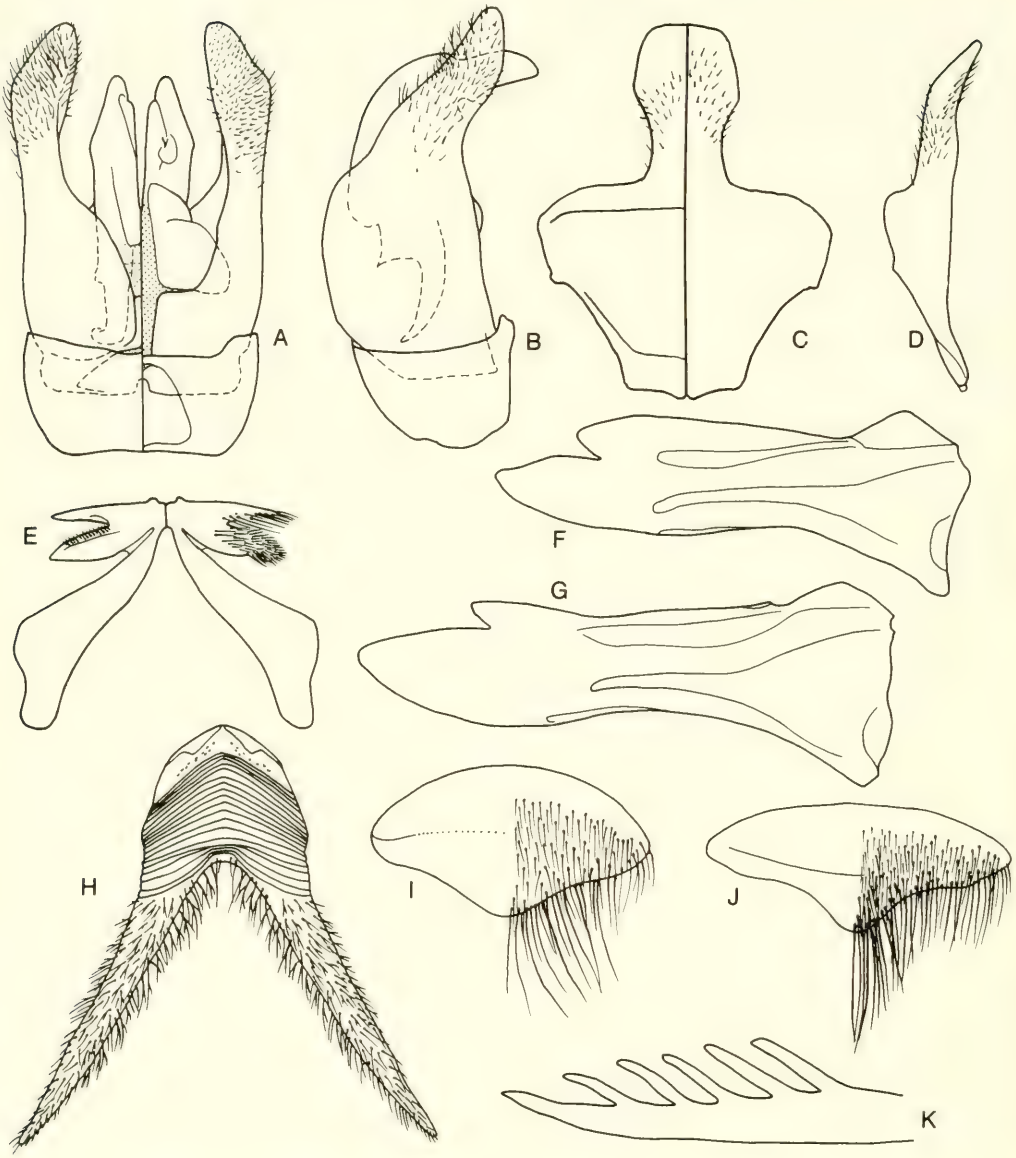

FIG. 6. *Leioproctus (Glossopasiphae) plaumanni* n. sp. **a-f.** Genitalia, S8 and S7, and mandible of male. **g, h.** Mandible and glossa of female. **i, j.** Labrum of male and female. **k.** Inner hind tibial spur of female.

exceptional) characters listed for *Perditomorpha* except as follows: a. Length 7-11 mm. Pubescence mostly pale, forming apical bands of pale hair on terga. Metasoma of male broad so that body form is like that of female. b. Inner orbits only slightly converging below. d. Labrum two to three times as broad as long, apex gently convex or with small median concavity, apical bristles about as long as labrum; basal three fifths to four fifths a convex bare zone, more elevated in female than male, this convexity weakly depressed medially. Maxillary palpus reaching little if any beyond apex of rather long galea, postpalpal part of which is as long as prepalpal part. f. Ocellar position variable as described for *Perditomorpha*. Vertex behind ocelli well developed, convex. g. Male flagellum sometimes, as in *L. (S.) rufipennis*, not reaching tegula, middle segments slightly broader than long to longer than broad. h. Propodeum variable as in *Perditomorpha*. i. Basitibial

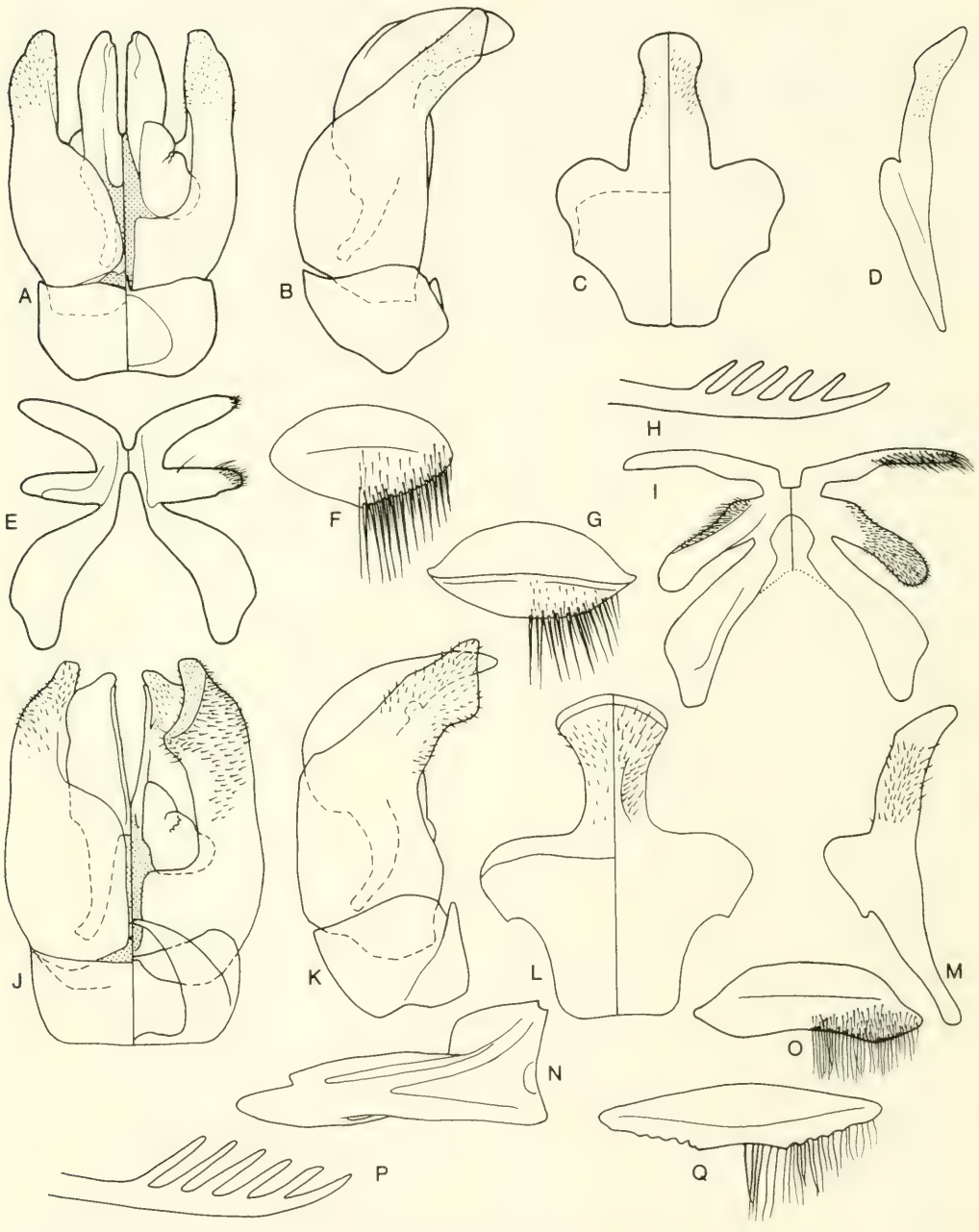

FIG. 7. **a-h.** *Leioproctus (Sarocolletes) duplex* n. sp. **a-e.** Genitalia, S8 and S7 of male. **f, g.** Labrum of male and female. **h.** Inner hind tibial spur of female. **i-o.** *L. (Holmbergeria) rubriventris* (Friese), male. **i.** S7. **j-m.** Genitalia and S8. **n, o.** Mandible and labrum. **p, q.** *L. (Hoplocolletes) ventralis* (Friese), female, inner hind tibial spur and labrum.

plate variable as in *Perditomorpha*, rounded in *L. (S.) rufipennis*. j. Femoral corbicula with a few short hairs on surface; hairs anterior to corbicula and on trochanter with numerous rather short, fine branches along rachis, often shorter than those on tibial scopal hairs; hairs posterior to corbicula simple. Tibial scopa with hairs of lower margin not curbed upward, scopa extending farther below tibia than above, hairs of entire tibial scopa with numerous short, fine side branches along rachis similar to those illustrated for *L. (Protodiscelis) palpalis* (Fig. 19e). l. Wings *usually with three submarginal cells*, two only in *L. (S.) duplex*. m. *S2-5 of female with strong scopa of long (as long as exposed part of sternum), dense, sloping hairs* with numerous short, fine side branches that tend to be at right angles to rachis and curled basad, as on tibial hairs of *L. (Glossopasiphae) plaumanni* (Fig. 19d). S7 of male with median bare area convex, tapering posteriorly, as in *L. (Perditomorpha) zonatus*. n. S7, S8, and male genitalia as shown in Fig. 7a-e. Lateroapical lobes of S7 rather slender, somewhat as in *L. (Chilicolletes) delahozii*, all in same plane; *ventral projection of S8 extremely weak* (Fig. 7d).

Distribution: Argentina, the provinces of Buenos Aires and Entre Rios to Tucumán, including Santiago del Estero, Santa Fe, Catamarca, and La Rioja.

Included species: Leioproctus (Sarocolletes) rufipennis (Cockerell, 1917) [*Lonchopria*] and its probable synonym, *parvus* (Cockerell, 1917), proposed as a variety of *rufipennis*. In addition, it contains at least five apparently undescribed species. All of the above have three submarginal cells. It also includes *L. (S.) duplex* Michener, n. sp., described in the Appendix, which is exceptional among species of *Sarocolletes* only in having two instead of three submarginal cells.

Comments: Padre J. S. Moure recognized the species with three submarginal cells as a group and named it with specimen labels before 1956. I have not accepted his name since it indicated a relationship to *Lonchopria*. The possibility that this subgenus is a synonym of *Holmbergeria* is discussed under that subgenus.

Etymology: The name *Sarocolletes* is based on the Greek *saron*, brush or broom, plus the generic name *Colletes*, with reference to the large ventral scopa in females of this subgenus.

Subgenus *Holmbergeria* Jörgensen

Holmbergeria Jörgensen, 1912:100. Type species: *Holmbergeria cristariae* Jörgensen, 1912 (monobasic).

This subgenus is known only from the male. When female characters are known, its relationships may be clarified. If the female scopa turns out to be like that of *Sarocolletes*, that subgenus might well be regarded as a synonym of *Holmbergeria* in spite of the peculiar facial features (italicized below) of the males of the latter. (Figs. 7i-o, 10d)

Description: Agreeing with usual (rather than exceptional) characters of *Perditomorpha* except as follows: a. Metasoma sometimes partly red (T1-2 or 1-3). Length 9-11 mm. Pubescence pale, dusky on vertex and distal metasomal segments, with strong apical bands of pale hair on terga. b. Face broad, *inner orbits parallel*. c. *Supraclypeal area small, convex, hairless, shining and impunctate; subantennal area shorter than diameter of antennal socket, flat, hairless, shining, impunctate*, in contrast to rest of face which is punctate and hairy. d. Labrum about three times as wide as long; apical bristles mostly not longer than labrum; basal half elevated, smooth, shining; distal half with small hairs basal to apical bristles. e. Maxillary palpus with little more than last segment extending beyond apex of galea. f. Anterior margin of median ocellus at midpoint between antennal bases and posterior margin of vertex or nearer to the former; vertex strongly developed, convex. g. Flagellum reaching tegula or not, middle segments as long as broad or slightly longer than broad. h. Propodeum with subhorizontal surface (in profile) shorter than metanotum, rounding onto sloping (slanting) posterior surface; triangle smooth or feebly wrinkled, marginal line not pitted. i. Basitibial plate with apex rounded, surface hairy except at margins. k. Tibial spurs (male) with margins ciliate. l. Three submarginal cells, 2 + 3 about as long as 1, 2 shorter than 3, receiving first recurrent vein in apical half; jugal lobe of hind wing extending beyond level of cu-v. m. S6 (male) unmodified. Pygidial plate absent but with hairless longitudinal median bare area, narrowed toward posterior margin of tergum. n. S7, S8 and genitalia as in Fig. 7j-m. S7 with two slender apicolateral lobes; *S8 with apical process not bent downward, without ventral protuberance* but with longitudinal ridge in its place; membranous area at apex of gonostylus well defined.

Distribution: Argentina, provinces of Mendoza to Santiago del Estero; Paraguay.

Included species: Leioproctus (Holmbergeria) cristariae (Jörgensen, 1912) and *L. (H.) rubriventris* (Friese, 1909) [*Biglossa*]. These forms are morphologically very similar; the former has the legs and metasoma black, while the latter has the legs and first two or three metasomal terga red. (See Appendix for details on *L. cristariae*.).

Subgenus *Hoplocolletes* Michener

Leioproctus (Hoplocolletes) Michener, 1965:42. Type species: *Dasycolletes ventralis* Friese, 1924, by original designation.

This subgenus is recognized only on the basis of a combination of female characters most of which are duplicated in other *Leioproctus*. The combination of the characters found in *L. (Hoplocolletes) ventralis*, however, suggests a form quite

dissimilar to other subgenera; discovery of the male will, of course, greatly assist in placement of *Hoplocolletes*. (Fig. 7, p-q)

Description: Agreeing with usual (not exceptional) female characters listed for *Perditomorpha* except as follows: a. Length 12 mm. Pubescence short, sparse, blackish except on hind legs and metasomal sterna where there are long, pale hairs; metasomal hair bands absent. b. *Inner orbits subparallel*. d. Labrum with apical margin concave medially; elevated zone highest medially, occupying about basal half of labrum. f. Ocelli well forward so that anterior margin of median ocellus is nearer to antennal bases than to posterior margin of vertex. h. Propodeum with subhorizontal surface about as long as metanotum, triangle smooth, marginal line pitted. i. Basitibial plate rather slender, pointed. j. Femoral scopa sparse, *hairs in front of corbicula mostly simple or bifurcate*, those behind corbicula and *on trochanter long but simple*. Tibial scopa sparse but hairs long, those of lower margin curved apicad, branched as in *Perditomorpha*, but many hairs of outer and upper surfaces with main axes extending beyond the one or few long branches; scopa extending farther above tibia than below; hairs of inner surface of tibia as long as scopal hairs and thus not like keirotrichia. l. Three submarginal cells, second much shorter than third and receiving recurrent vein beyond middle; basal vein of forewing slightly beyond cu-v. m. S3-5 with dense, long (shorter than exposed part of sternum), pale yellow, simple hairs (some hooked at tips) forming band occupying apical half of each sternum; S2 with similar but sparser hair band.

Distribution: Rio de Janeiro, Brazil.

Included species: Leioproctus (Hoplocolletes) ventralis (Friese, 1924).

Comments: The very coarsely punctate head and thorax of *Hoplocolletes* suggest *L. (Perditomorpha) iheringi* and *eulonchopriodes*, although the dorsum of the thorax is even more coarsely and less closely punctate. The metasoma, however, is nearly impunctate (T1-2) or finely punctate (T3, etc.) in *L. ventralis*, and the subparallel inner orbits, the three submarginal cells, the very deeply impressed median line of the anterior half of the scutum, the deeply impressed parapsidal lines, the simple hind trochanteral hairs, and the strong ventral scopa further differentiate *Hoplocolletes*. (A superficially similar black species known in both sexes, *L. (Tetraglossula) anthracinus* Michener n. sp., from the same area as *L. ventralis*, has been identified as that species in some collections.)

The only known species of this subgenus, *L. (H.) ventralis* (Friese), was described from Sydney, Australia. The specimens must have been mislabeled, for the species is now known from the vicinity of Rio de Janeiro, Brazil (Michener, 1965:42); one specimen [Lawrence].

Pygopasiphae new subgenus

Type species: *Leioproctus mourellus* new species.

The most distinctive characters of *Pygopasiphae* are the short, erect, unbranched, capitate hairs of the metasomal sterna of the female, and the distinct pygidial plate and long, slender hind tarsi of the male. (Figs. 8, 10h, 19f)

Description: Agreeing with usual (rather than exceptional) characters listed for *Perditomorpha* except as follows: a. Metasoma and legs red in some females of *L. mourellus*, black in other species. Length 7-11 mm. Pubescence largely pale (sometimes partly dusky on vertex, tibiae, and metasomal terga), forming apical pale bands on T1 or 2 to 4. b. *Inner orbits slightly converging below to subparallel in females*, converging in males; upper parts converging above. e. Maxillary palpus with about one segment extending beyond end of galea. g. Male flagellum reaching beyond tegula, middle segments about 1.5 to 1.8 times as long as broad. h. Propodeum with subhorizontal basal zone almost as long as to slightly longer than metanotum; triangle smooth, marginal line pitted or not. i. Anterior basitarsus of female with weakly differentiated row of hairs on outer margin. Basitibial plate pointed at apex, largely covered by hair in female. j. Femoral scopa rather short and sparse (hairs on trochanter simple), hairs simple or (in *L. wagneri*) those on distal half of anterior side of femoral corbicula with several preapical branches surpassed by rachis. Tibial scopa whitish or upper outer zone along tibia dusky; *long scopal hairs along lower margin of tibia not curved upward, spreading as far below tibia as scopa spreads above tibia, these hairs* in *L. mourellus* plumose with several long branches exceeded by rachis, like hairs on outer face of tibia, in *L. wagneri* hairs of lower margin *simple* or with few short branches (Fig. 19f) although quickly grading to hairs with long branches (as in *Perditomorpha*) on outer surface of tibia. k. Hind trochanter and tibia of male unmodified in *L. mourellus*, in *L. wagneri* trochanter with strongly produced angle or tooth on under side and hind tibia enlarged and truncate apically, tibial spurs arising far from one another on truncate apex. *Hind tarsus of male elongate, segment 2 several times as long as broad. Tibial spurs of female nearly straight or slightly curved, apices blunt, margins almost entire or with a few small teeth except inner margin of inner spur which is pectinate with two to five large teeth.* Tibial spurs of male nearly straight, pointed, finely and briefly ciliate. l. Wings with distal two fifths with minute hairs, *basal parts much more sparsely hairy but with a few relatively long hairs*. m. Sterna of female without scopa, *hairs erect, of uniform length, uniformly dispersed* (not forming apical bands or fringes), tips bent slightly backward and *enlarged like keirotrichia*. S6 of male unmodified, short hairs directed laterad from broad longitudinal median elevation. Pygidial plate of female unusually large, apex rounded, not at all truncate. *T7 of male with well defined (by carina*

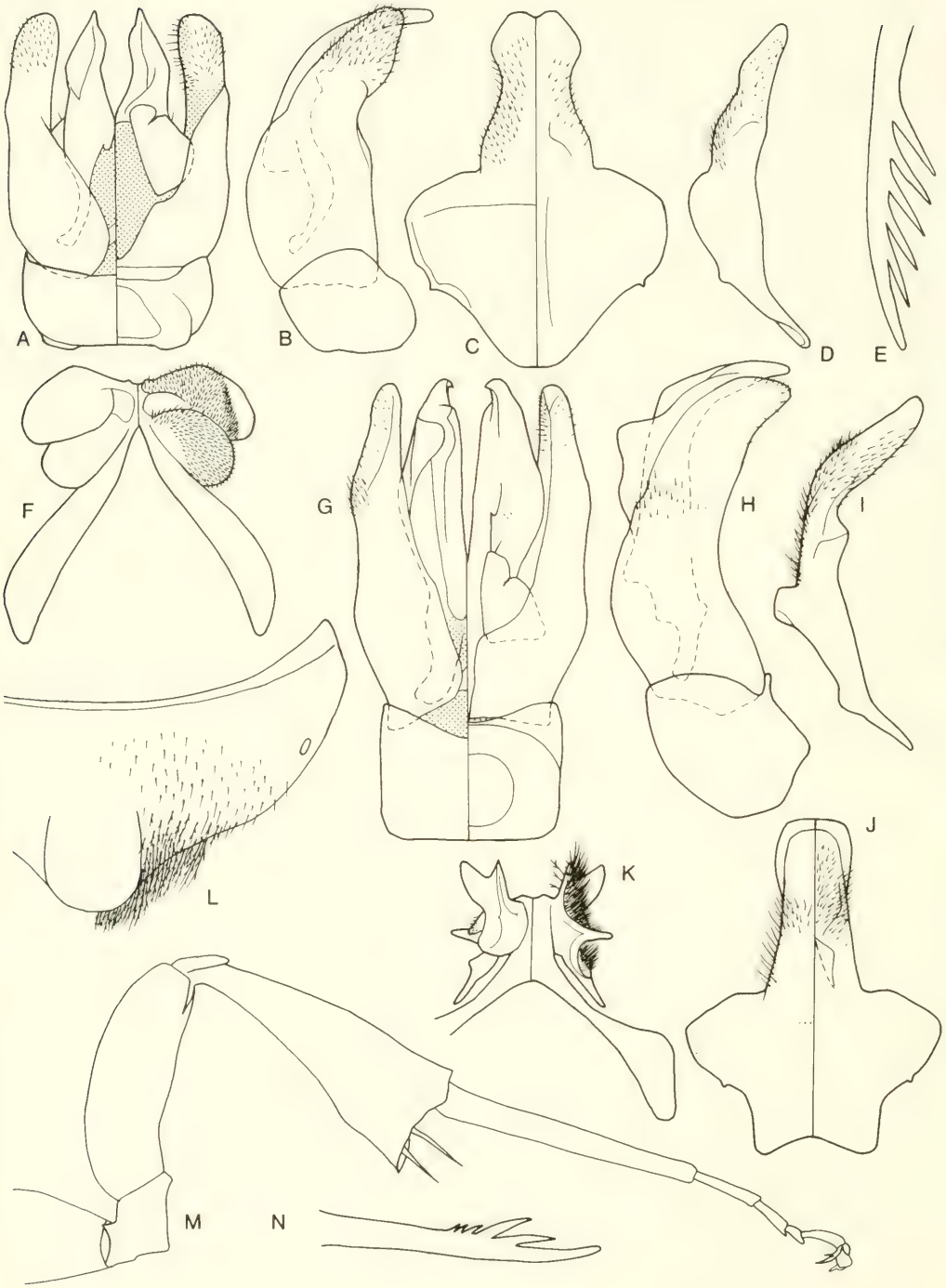

FIG. 8. **a-f.** *Leioproctus (Pygopasiphae) mourellus* n. sp. **a-d** and **f.** Genitalia, S8 and S7 of male. **e.** Inner hind tibial spur of female. **g-n.** *L. (P.) wagneri* (Vachal). **g-k.** Genitalia, S8 and S7 of male. **l.** T7 of male. **m.** Hind leg of male. **n.** Inner hind tibial spur of female.

posteriorly) pygidial plate, rounded posteriorly (in *L. wagneri* slightly narrowed basally). S7, S8, and genitalia of male as in Fig. 8. S7 with apical lobes variable in shape (Fig. 8f, k), *hairs all or nearly all on ventral surfaces*; S8 with process nearly straight or in *L. wagneri* strongly down-curved; gonostylus not separate from gonocoxite or separation visible only on ventral side.

Distribution: Xeric parts of Argentina (provinces of Santiago del Estero, Catamarca, La Rioja).

Included species: Leioproctus (Pygopasiphae) wagneri (Vachal, 1909) [*Pasiphae*], *L. (P.) mourellus* Michener, n. sp., and several undescribed species.

Comments: L. mourellus is less extreme in various ways than the larger species with modified male legs such as *L. wagneri*. I have made *L. mourellus* the type species because I have not seen type specimens of *L. wagneri*. The subgenus was first recognized (as a genus) by Moure over 30 years ago but, although he labeled specimens, he never published a description. Michener (1965) included *L. wagneri* in the subgenus *Bicolletes* (= *Perditomorpha*).

Etymology: The subgeneric name is based on the Greek *pyge*, rump, with reference to the pygidial plate of the male, and *pasiphae*, an invalid generic name for paracolletines with only two submarginal cells (see subgenus *Spinolapis*).

Subgenus *Halictanthrena* Ducke

Halictanthrena Ducke, 1907:364. *Type species: Halictanthrena malpighiacearum* Ducke, 1907 (monobasic).
Leioproctus (Halictanthrena), Michener, 1965:42.

Distinctive features of the subgenus are the sharp tooth on the dorsolateral angle of the pronotum and the presence of erect hairs and lack of distinctive short hairs on the basitibial plate of the female. The subgeneric name suggests a bee with the aspect of *Halictus* or *Andrena*, probably with pale pubescence and a banded metasoma. *Halictanthrena*, however, is a rather slender bee with largely dark hair, no metasomal hair bands, and with the partially red metasoma suggesting *Sphecodes* more than *Halictus*. (Figs. 9, 10i)

Description: Agreeing with usual (rather than

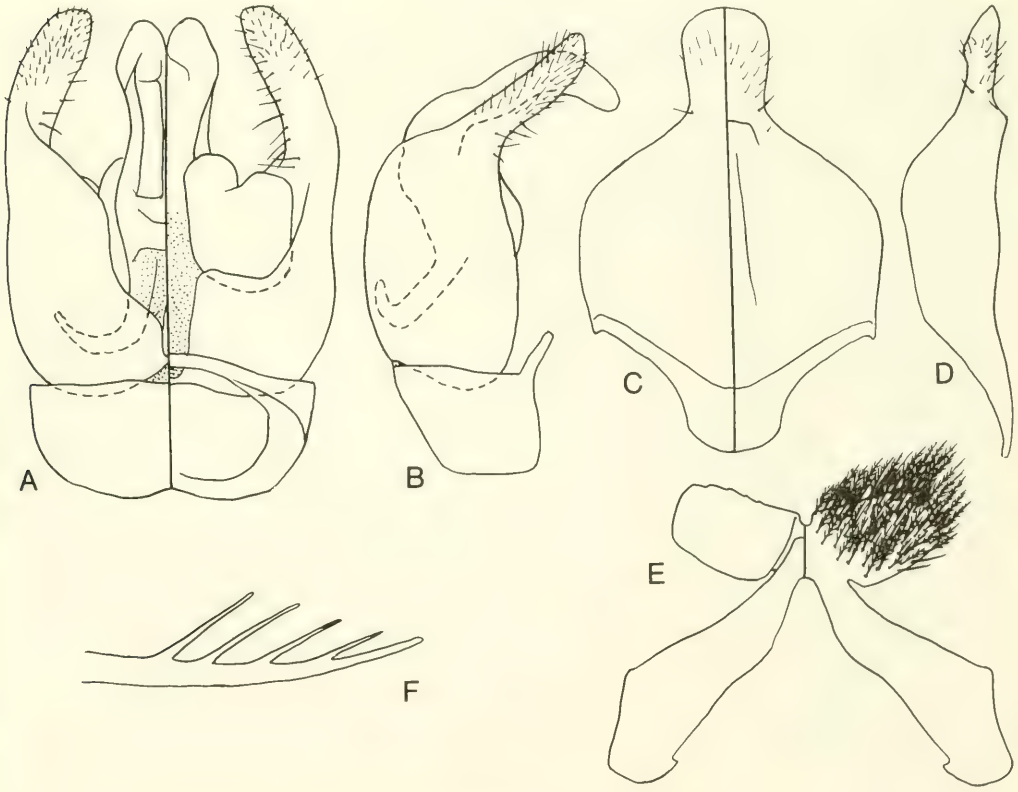

FIG. 9. **a-f.** *Leioproctus (Halictanthrena) malpighiacearum* (Ducke). **a-e.** Genitalia, S8 and S7 of male. **f.** Inner hind tibial spur of female.

exceptional) characters listed for *Perditomorpha* except as follows: a. First two metasomal terga dark red in female, metasoma largely red-brown in male. Length 6.5-9 mm. Pubescence of female blackish on dorsum, tibiae and basitarsi, pale yellow on face below antennae, sides and venter of body, femora, and lower margin of hind tibia; f male pale yellowish, dusky on dorsum, some black hairs intermixed on scutellum. c. Clypeus with scattered coarse punctures, only sparsely haired. d. Labrum over four times as wide as long, apical margin weakly convex. e. *Mandible of female (not male) with convexity on upper margin basal to preapical tooth*, suggesting a tridentate condition. g. Male flagellum reaching scutellum, middle segments about 1.5 times as long as wide. h.

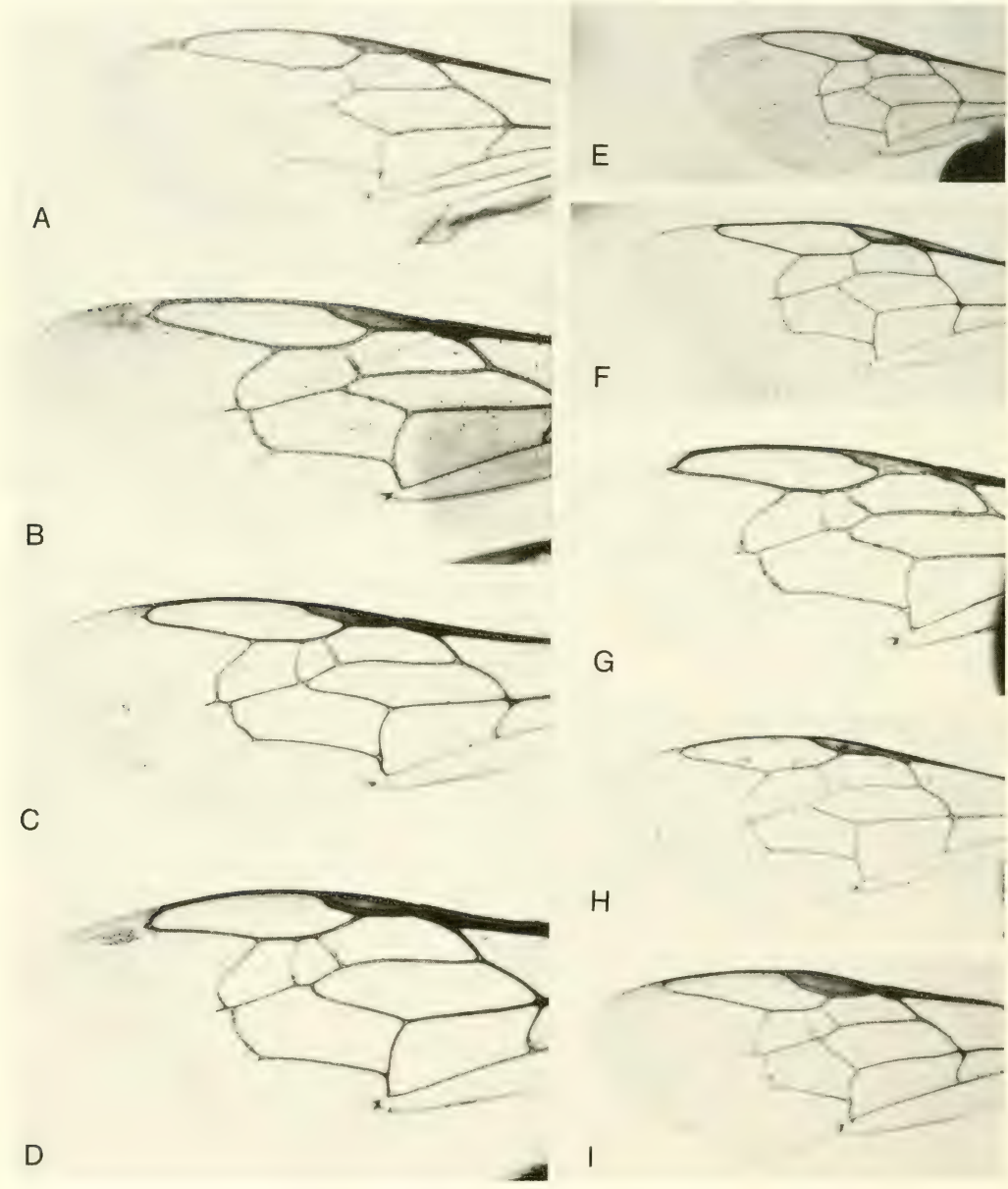

FIG. 10. Forewings. **a.** *Leioproctus (Perditomorpha) brunerii* (Ashmead). **b.** *L. (P.) flavicornis* (Spinola). **c.** *L. (Chilicolletes) delahozii* Toro. **d.** *L. (Holmbergeria) rubriventris* (Friese). **e.** *L. (Perditomorpha) neotropicus* (Friese). **f.** *L. (Kylopasiphae) pruinosus* n. sp. **g.** *L. (Sarocolletes) rufipennis* (Cockerell). **h.** *L. (Pygopasiphae) mourellus* n. sp. **i.** *L. (Halictanthrena) malpighiacearum* (Ducke).

Dorsolateral angle of pronotum with small, sharp tooth, projecting dorsolaterally, shorter than nearby hairs, in male so small as to be difficult to see except in profile. Propodeum with subhorizontal surface strongly sloping, about as long as metanotum, gradually curving onto declivous surface. i. *Front basitarsus of female with abundant coarse bristles*, strongly curved at apices, on outer surface. j. Scopal hairs on outer side of tibia often with rachis extending slightly beyond other branches. Scopal hairs near upper margin of tibia particularly coarse near bases, shorter near base of tibia, similar *coarse, nearly erect hairs arising from and nearly hiding basitibial plate* which is pointed apically; *anterior carina of basitibial plate of female weak for short distance preapically*. l. Three submarginal cells, 2 much shorter than 3; basal vein of forewing approximately meeting cu-v; jugal lobe of hind wing reaching distinctly beyond level of cu-v. m. S6 of male broadly convexly subtruncate. Pygidial plate of male represented by broad, smooth hairless area delimited posteriorly by distinct, convex carina. n. S7, S8, and genitalia of male as in Fig. 9a-e; S7 with a single hairy apicolateral lobe on each side, *S8 with apical process short and shoulders sloping*.

Distribution: State of Minas Gerais, Brazil.

Included species: Leioproctus (Halictanthrena) malpighiacearum (Ducke, 1907).

Comments: This distinctive subgenus is known to me only from a single pair of specimens [Berlin]. Characters not listed above include the unusually large stigma (Fig. 10i), larger than in any other American colletine, and the opposed teeth on the male volsella (not exposed in ventral view).

Torocolletes new subgenus

Grupo Fazii Toro, 1973a:156. Type species: *Lonchopria fazii* Herbst, 1923.

The largely dull integument without recognizable punctures except on the clypeus is characteristic of this subgenus, as are the protuberant clypeus, distinct malar area, reduced jugal lobe of the hind wing, and other characters italicized below. (Fig. 16a; Figs. 115-132, Toro, 1973a)

Description: a. Integument dark blue to black, *except for clypeus with only minute and widely separated punctures on finely roughened surface, that of head and thorax dull*. Length 7-11 mm. Pubescence mostly pale, not forming bands on terga. b. Inner orbits converging below. c. Clypeus moderately coarsely punctate, lower lateral areas more sparsely so and shiny than flat median area. *Clypeus produced well below lower tangent of eyes and protuberant in front of eye by about eye width. Malar area longer than flagellar diameter*. d. *Labrum of both sexes convex, shining, twice as broad as long or slightly more; apex strongly convex; fringe little if any longer than labrum*; apicolateral lobe absent (illustrated by Toro, 1973). e. Maxillary palpus with segment 3 reaching beyond apex of galea, segments 4-6 together slightly longer than 1-3 together. Mandible with preapical tooth on upper margin in both sexes (illustrated by Toro, 1973). Glossa with lobes broader than long. f. Ocelli as usual in *Perditomorpha*, vertex not at all elevated, flat or concave between ocelli and summit of eye. g. Male flagellum reaching front of scutellum, middle segments about 1.5 times as long as broad. h. Propodeum with subhorizontal surface sloping, about as long as metanotum; *propodeal triangle dull, minutely and closely areolate*, marginal line not pitted. i. Anterior basitarsus of female without comb or row of hairs. Basitibial plate defined by carina, narrowly rounded at apex in both sexes. j. Femoral and tibial scopa sparse, hairs not very long; femoral corbicula with scattered short hairs, mostly with one or two branches, on surface; hairs anterior to corbicula with a few long branches surpassed by rachis; hairs posterior to corbicula simple in contrast to long, loosely plumose hairs on trochanter; tibial scopa with hairs of lower margin as described for *Perditomorpha* but usually with one branch (rachis) surpassing the others, hairs of outer surface and especially upper margin of tibia with two or three long branches but rachis strong and bare beyond the branches. k. Tibial spurs straight, inner margin of inner hind spur finely pectinate to coarsely ciliate (illustrated by Toro, 1973). l. Wings with minute hairs distally, hairs longer and sparser basally; three submarginal cells, cell 2 much shorter than 3 and receiving first recurrent vein near middle; basal vein meeting or beyond cu-v; *jugal lobe of hind wing terminating well before cu-v and scarcely over half as long as vannal lobe*. m. S2-5 of female with distinct preapical bands of mostly simple, suberect hair similar to that of *Perditomorpha*; hairs markedly shorter than length of sternum. S6 of male unmodified. Pygidial plate of male absent, not represented by area of sparser hair. n. S7, S8, and genitalia of male as illustrated by Toro (1973), not differing from those of *Perditomorpha*; S7 with lobes slender as in *L. (Chilicolletes) delahozii*.

Distribution Central Chile.

Included species: Leioproctus (Torocolletes) fazii (Herbst, 1923) [*Lonchopria*] and *ibanezii* (Ruiz, 1944) [*Lonchopria*]. (Some specimens at Lawrence are probably erroneously labeled as from a locality in Cordoba Prov., Argentina; see Daly et al., 1987, for comments on similarly labeled *Manuelia*.)

Comments: Both species of *Torocolletes* were erroneously included in *Lonchopria* by Michener (1965).

Although the sternal hairs of the female resemble those of most *Perditomorpha* and *Chilicolletes*, specimens with tibial pollen loads do not have pollen on the sternum as is usual in *Perditomorpha*.

In its distinct malar space, *Torocolletes* resembles *Nesocolletes* from New Zealand. The latter subgenus, however, has only one pair of small later-

oapical lobes on S7 of the male, a subvertical propodeal profile (i.e., without the long subhorizontal surface found in *Torocolletes*), and is punctate and shining (i.e., without the distinctive dull cuticle of *Torocolletes*). The somewhat elongate malar space is presumably of independent origin in the two groups. Some undescribed Australian species of *Leioproctus* also have elongate malar areas but in other characters are unrelated to *Nesocolletes* and *Torocolletes*.

Etymology: The subgeneric name is a patronymic for Haroldo Toro of Valparaiso, Chile, who first characterized the group, plus the generic name *Colletes*.

Subgenus *Hexantheda* Ogloblin

Hexantheda Ogloblin, 1948:172. Type species: *Hexantheda missionica* Ogloblin, 1948, by original designation.

The long, six- or seven-segmented labial palpi are unique. The metasoma of the male is robust like that of a female. (Figs. 11, 16b; Figs. 16-23, Ogloblin, 1948)

Description: Agreeing with usual (not exceptional) characters of *Perditomorpha* except as follows: a. Length 8-12 mm. *Male metasoma broad like that of female.* Pubescence mostly whitish, forming at most weak pale tergal bands. b. Inner orbits slightly converging below (except for upper extremities) in female, almost parallel in male. c. *Clypeus protuberant in front of eye by about eye width.* d. Labrum over four times as wide as long; apical margin feebly convex in female, weakly concave in male; bare convex surface depressed medially in male. e. Mandible of male with upper margin basal to preapical tooth convex (Fig. 11e). Maxillary palpus not attaining apex of galea. *Labial palpus two-thirds as long as prementum, much longer than maxillary palpus, six- or seven-segmented* (illustrated as 6-segmented by Ogloblin, 1948). f. Vertex considerably extended and convex behind the unusually small ocelli. g. Male flagellum scarcely reaching mesoscutum, *middle segments much broader than long* (illustrated by Ogloblin, 1948). h. Propodeum with subhorizontal surface a little shorter than metanotum; triangle shining, transversely wrinkled, marginal line not pitted. i. Basitibial plate narrowly rounded at apex in female, pointed in male. *Male with strong carina extending from apex of basitibial plate to apex of tibia.* j. Tibial scopa rather sparse, some hairs on lower margin simple and nearly straight so that scopa extends farther below tibia than above, but most hairs near lower margin curved upward and with long branches as in *Perditomorpha*; hairs of most of outer surface simple or with one or two branches directed apicad, rachis surpassing branches. k. Tibial spurs gently curved, those of male and of mid tibia of female ciliate, hind spurs of female serrate except inner margin of inner spur which is

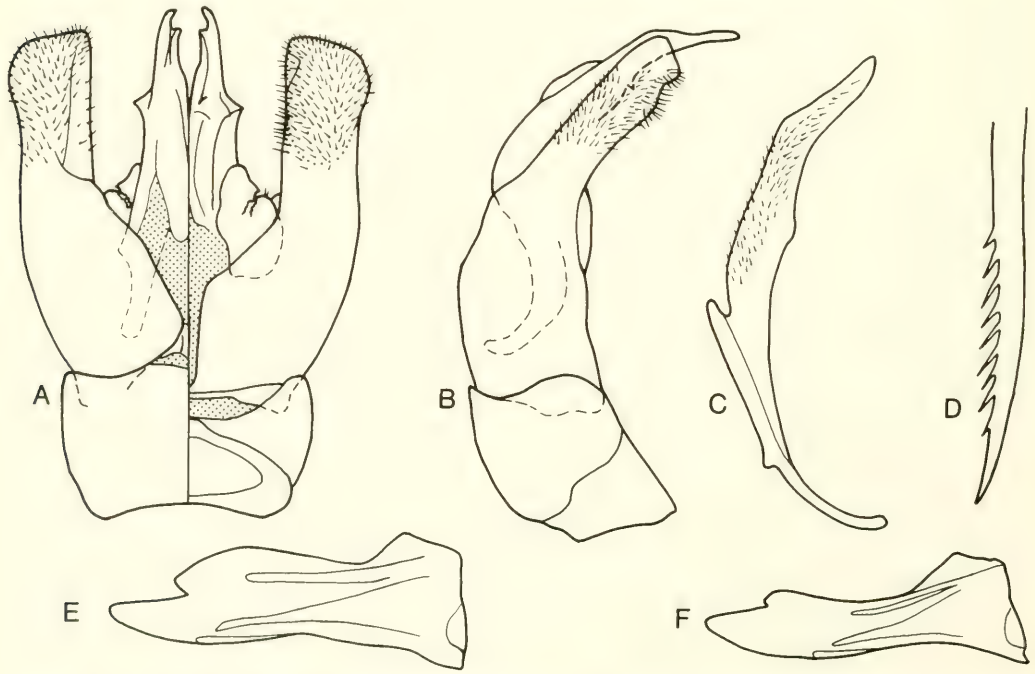

FIG. 11. *Leioproctus (Hexantheda) missionica* (Ogloblin). **a-c.** Genitalia and lateral view of S8 of male. **d.** Inner hind tibial spur of female. **e, f.** Mandibles of male and female.

pectinate with slender teeth (Fig. 11d). l. Basal vein of forewing meeting cu-v. m. S5 of male with long apical fringe. T7 of male with convex, bare pygidial area, tapering posteriorly, as in *L. (Perditomorpha) zonatus*. n. S7, S8, and genitalia of male as illustrated by Ogloblin (1948); see also Fig. 11a-c. S7 with apical lobes not broad and rounded as is common in *Perditomorpha*, basal one deeply divided so that there are *three lobes on each side* instead of two. Process of S8 downcurved.

Distribution: Southern Brazil (state of Paraná) and northern Argentina (provinces of Misiones and Formosa).

Included species: Leioproctus (Hexantheda) missionica (Ogloblin, 1948), new combination.

Comments: Michener (1965) considered *Hexantheda* to be a genus distinct from *Leioproctus* but the long labial palpi with a variable number of segments are the single character that might justify such placement. *Hexantheda* is probably a derivative of *Perditomorpha*-like ancestors with a few striking autapomorphies such as the labial palpi.

Subgenus *Protodiscelis* Brèthes

Protodiscelis Brèthes, 1909:245. Type species: *Protodiscelis fiebrigi* Brèthes, 1909 (monobasic).
Leioproctus (Protodiscelis); Michener, 1965:42.

Protodiscelis resembles *Tetraglossula* in the simple mandibles of the male (a character found otherwise in American *Leioproctus* only in the unrelated subgenus *Cephalocolletes*) and in the presence of apicolateral lobes on the very short labrum of the female. These are both apomorphies that unite the two subgenera. *Protodiscelis* differs from *Tetraglossula*, however, in numerous features such as the scarcely elongate glossa and the plumose scopal hairs of both metasomal sterna and hind legs. (Figs. 12, 16e, 19e)

Description: Agreeing with usual (rather than exceptional) characters listed for *Perditomorpha* except as follows: a. Length 6-9 mm. Pubescence all pale or that of dorsum brown to dusky, sometimes scopa dusky; hairs forming at most weak apical bands on metasomal terga which usually lack hair bands. b. Inner orbits converging below to nearly parallel; *paraocular area convex in female* except upper parts where there is a shiny, depressed, usually ill-defined fovea extending onto vertex and mesad toward ocelli. d. *Labrum a transverse band six times as wide as long or nearly so*, surface entirely occupied by convexity which in males and some females is lower medially, sometimes with small weak median convexity between larger lateral ones; apical margin rather straight, with bristles longer than labrum, *female with apicolateral lobe* [usually smaller than in *L. (P.) spathigerus*, Fig. 12f, l]. e. *Maxillary palpus long, apex of third segment beyond apex of galea. Mandible of male not toothed, of female unusually slender with preapical tooth small. Glossa with lobes unusually prominent*, as broad as long or longer. h. Propodeum with subhorizontal surface nearly as long as to longer than metanotum; triangle shining and nearly smooth or transversely striate, marginal line usually not pitted. Basitibial plate narrowly rounded to pointed at apex. j. *Femoral corbicula usually with rather long, mostly simple hairs arising from surface. Hairs on anterior and posterior sides of corbicula, also hairs of trochanter, long, rather dense, with numerous short branches* (similar to those of tibial scopa. Tibial scopa strong but not obscuring surface, hairs of lower margin bent apicad but not upward, hairs extending farther below than above tibia, *strongly plumose, rachis surpassing the numerous short branches* (Fig. 19e); hairs of inner surface of tibia mostly plumose but on distal half an area of long, unbranched but apically capitate keirotrichia; hairs of hind basitarsus on outer surface and upper margin plumose. k. Tibial spurs straight or gently curved, *inner hind tibial spur finely pectinate* (Fig. 12i, k), others ciliate. l. Jugal lobe of hind wing slightly to distinctly exceeding level of cu-v. m. S2-6 of female with apical bands of sloping to erect hair; hairs considerably shorter than exposed parts of sterna, plumose with numerous short branches like scopal hairs of hind leg. n. S7, S8, and genitalia as in Fig. 12a-d. Gonostylus much narrower than body of gonocoxite.

Distribution: Northeastern Brazil (Paraiba) to the state of Paraná and to Paraguay.

Included species: Leioproctus (Protodiscelis) fiebrigi (Brèthes, 1909), *spathigerus* Michener, n. sp., and probably *palpalis* (Ducke, 1908) [*Panurginus*]. There are also several undescribed species. In the American Museum of Natural History there are "typus" specimens of an apparently unpublished Friese species named for its piceous coloration. An undescribed species from the State of Rio de Janeiro, Brazil, is unusually large (9 mm long) with the head longer than broad. The male is unknown; two females are at [Lawrence]. I have not seen authentic specimens of *L. palpalis*; its tentative placement here is based on specimens identified largely because of Ducke's remarks on its large maxillary palpi.

Comments: Recognition of the subgeneric name *Protodiscelis* has been difficult. Ducke (1912) and Cockerell (1919) placed it with *Oediscelis (= Chilicola)* in the Xeromelissinae, perhaps largely because of the name, while Schrottky (1913) included it in the "Prosopidae" (= Hylaeinae). For one familiar with ordinary, rather hairy paracolletines, the subgeneric name and placements in Xeromelissinae or Hylaeinae seem to indicate a form not in the Paracolletinae. However, some species of *Protodiscelis* such as *L. (P.) fiebrigi* (Brèthes) have such short and sparse hair that the males superficially resemble *Chilicola* or other Xeromelissinae. As explained in the Appen-

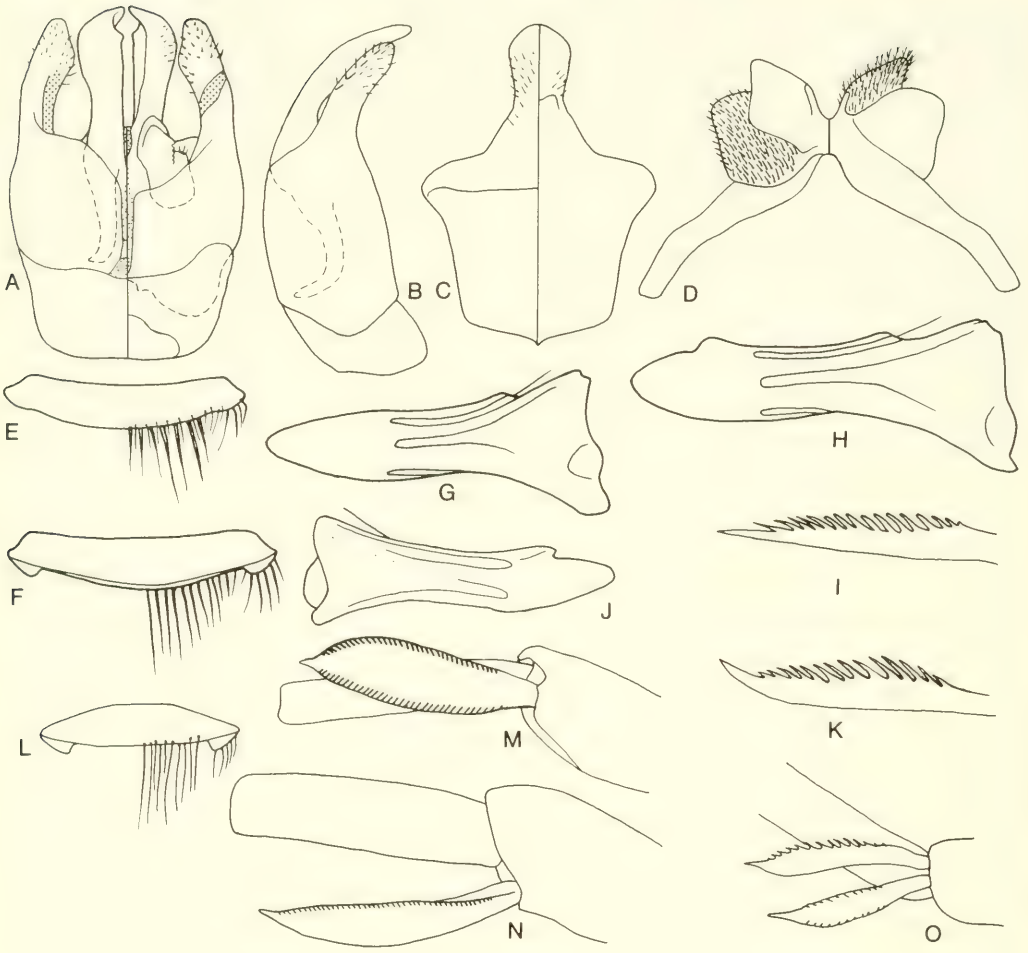

FIG. 12. **a-d.** *Leioproctus (Protodiscelis) fiebrigi* (Brèthes), male holotype, genitalia, S8 and S7. **e-i.** *L. (P.) palpalis* (Ducke)? **e, f.** Labrum, male and female. **g, h.** Mandible, male and female. **i.** Inner hind tibial spur of female. **j-o.** *L. (P.) spathigerus* n. sp., female. **j.** Mandible. **k.** Inner hind tibial spur. **l.** Labrum. **m, n.** Ventral and anterior views of middle tibial spur, apex of tibia, and basitarsus. **o.** Ventral view of hind tibial spurs, inner spur above.

dix, Brèthes described a male, thinking that it was a female; of course it did not have a scopa and other features of female Paracolletini.

Moure (1951) discussed *Protodiscelis* briefly among groups now included in the Paracolletini, but gave no characters or indications of the reasons for that placement. It is here properly placed, near *Tetraglossula*, for the first time.

Subgenus *Tetraglossula* Ogloblin

Tetraglossula Ogloblin, 1948:165. Type species: *Tetraglossula deltivaga* Ogloblin, 1948, by original designation.

This subgenus was not included in *Leioproctus* by Michener (1965) but it is as much part of that genus as are the other subgenera. The simple mandible of the male shows its relationship to *Protodiscelis*, which has a slightly more bifid glossa than most subgenera, thus approaching *Tetraglossula*. The deeply bifid glossa suggests *Glossopasiphae*, which, however, has a subapical mandibular tooth in the male and plumose scopal hairs. (Figs. 13, 16f; Figs. 1-15, Ogloblin, 1948)

Description: Agreeing with usual (rather than exceptional) characters listed for *Perditomorpha* except as follows: a. Metasoma sometimes partly or largely yellowish red. Length 6-12 mm. Metasomal hair bands absent or weak. b. *Inner orbits not or very slightly converging below* (both sexes), *almost*

without concave region so that upper parts of orbit are not greatly different in orientation from remainder. d. Labrum about six times as wide as long; apical margin weakly concave to weakly convex; male with basal three fifths or more shining, convex, weakly binodulose; female with most of surface strongly elevated, *binodulose, between nodules with transverse depression surrounded by carinae; lateral lobes weak in male, conspicuous and serrate or pectinate in female*; apical bristles much longer than labrum. *Apical margin of clypeus of male with small median convex lobe overhanging labrum*. e. Maxillary palpus long, last or last two segments extending beyond apex of galea. *Mandible simple in male* (Ogloblin, 1948, Fig. 8), slender in female. *Glossa deeply bifid*, each lobe attenuate, hairy, seven to ten times as long as basal width (Ogloblin, 1948, Fig. 9) annulate part extending well out into base of each lobe. Galea much longer than stipes, postpalpal part pointed apically, four or five times as long as basal width (Ogloblin, 1948, Fig. 9). f. Ocelli in front of summit of vertex; vertex convex and rounded behind ocelli; anterior margin of median ocellus in front of to

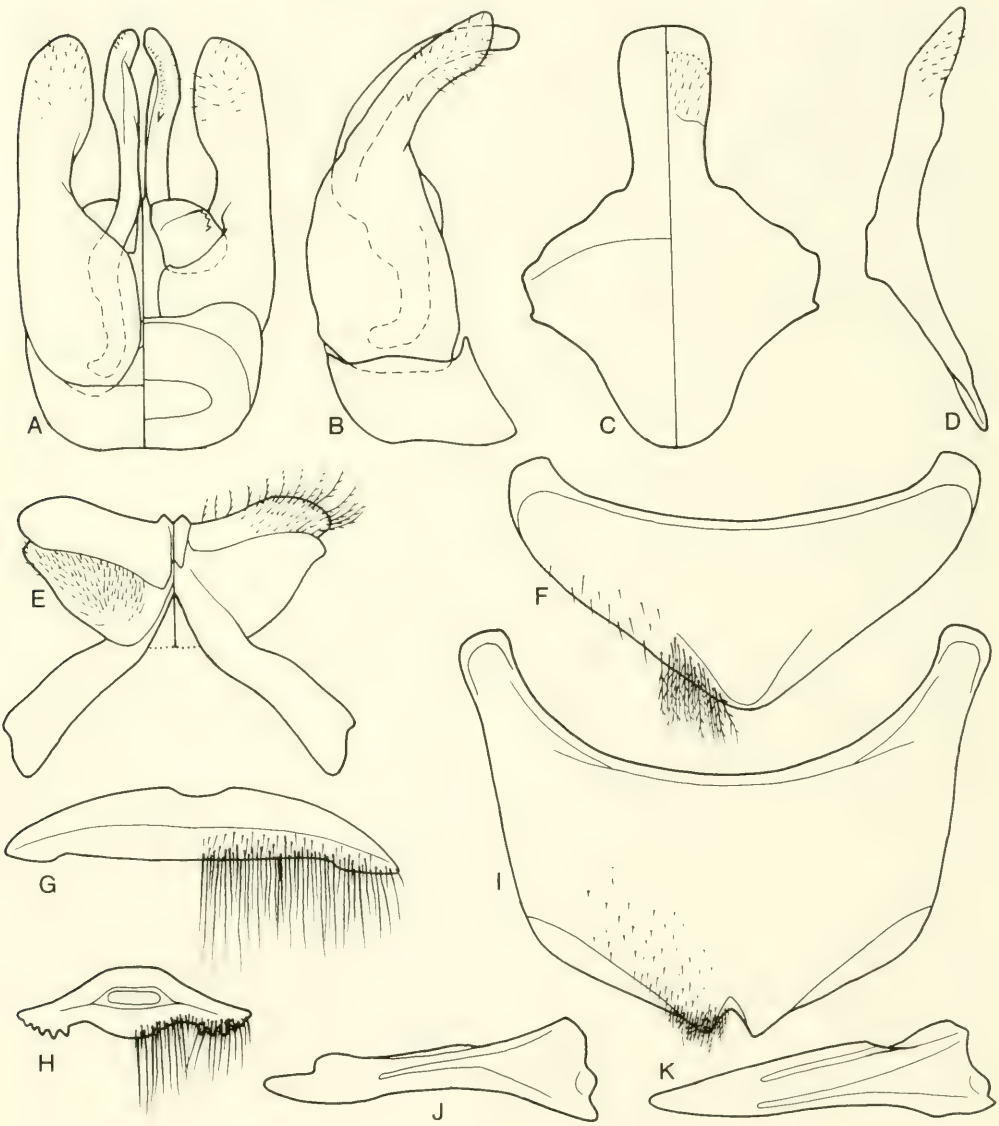

FIG. 13. *Leioproctus (Tetraglossula) fucosus* n. sp. **a-e.** Genitalia, S8 and S7 of male. **f.** T7 of male. **g, h.** Labrum of male and female (g at twice the magnification of h). **i.** S6 of male. **j, k.** Mandibles of female and male.

behind midpoint between antennal bases and posterior margin of vertex. g. Male flagellum not attaining tegula, middle flagellar segments distinctly broader than long. h. Propodeum with basal zone in profile sloping, about as long as metanotum; triangle smooth with marginal groove strongly pitted. i. Apex of basitibial plate narrowly rounded. j. Corbicular surface with some simple hairs on basal half. *Femoral and tibial scopa, and that of distal part of trochanter, of sparse simple hairs* (in *L. fucosus* many hairs of outer surface of tibia, except lower margin, with one or two branches, often three on hairs of upper margin); hairs of lower margin of tibia curved apicad but not extending farther below tibia than above. k. Tibial spurs straight or gently curved, inner margin of inner hind tibial spur pectinate, other margins ciliate (Ogloblin, 1948, Fig. 4). l. Basal vein of forewing meeting or distal to cu-v (Ogloblin, 1948, Fig. 3); jugal lobe of hind wing exceeding level of cu-v. m. *T7 of male with triangular, bare pygidial plate*, tapering to narrow rounded apex on tergal margin and margined laterally by weak carina, beyond which surface is densely hairy. S2-5 of female with scopa of simple hairs longer than length of sternum. n. S7, S8, and genitalia of male as in Fig. 13a-e (also Ogloblin, 1948, Figs. 5-7, 13-15).

Distribution: Argentina (provinces of Buenos Aires, Tucumán, and Misiones) and Brazil (states of Paraná, São Paulo, and Pará).

Included species (*marks species not seen by me): *Leioproctus (Tetraglossula) anthracinus* Michener, n. sp.; *bigamicus* (Strand, 1910) (= *Tetraglossula birabeni* Ogloblin, 1948, according to Moure, 1951), new combination; *deltivagus* (Ogloblin, 1948), new combination; *fucosus* Michener, n. sp.; and **stigmaticus* (Strand, 1910), new combination.

Comments: The species of *Tetraglossula* are quite diverse in appearance, although morphologically similar. *L. (T.) deltivagus*, *bigamicus*, and *stigmaticus* are black with pale pubescence and thus rather ordinary looking gray bees. *L. (T.) anthracinus* is black haired. *L. (T.) fucosus* is a smaller species with a largely reddish metasoma; superficially it exactly resembles females of *L. (Perditomorpha) brunerii*.

Reedapis new subgenus

Grupo *L. semicyaneus* Toro 1973a:162. Type species: *Leioproctus bathycyaneus* Toro, 1973.

Superficially the rather large, robust species of *Reedapis* closely resemble those of *Spinolapis* that are found in the same area. *Reedapis* differs from *Spinolapis* in having three submarginal cells, bifid claws in the female, rather uniformly punctured and hairy clypeus, rather short male flagellum, etc. The two groups are not closely related in spite of superficial appearance. *Reedapis* is actually more similar to *Perditomorpha* and *Chilicolletes*. It differs from those subgenera not only in appearance (and from *Perditomorpha* in having three submarginal cells) but also in the distinct row or comb of hairs on the outer margin of the front basitarsus of the female and in the strongly pectinate condition in females and some males of both inner and outer hind tibial spurs and of the mid tibial spur. The closest relative of *Reedapis* is *Cephalocolletes*; these subgenera differ conspicuously in the characters listed in the key. (Figs. 14h, i, 16c, 19g; Figs. 110-114, 133-152, Toro, 1973a)

Description: Agreeing with usual (rather than exceptional) characters listed for *Perditomorpha* except as follows: a. Integument black with the metasoma at least weakly metallic blue. Length 9 to 15 mm. Head, venter of thorax, and metasoma with much black hair. T1-3 with apical bands of white hair, sometimes weak on T1 and weakly indicated on T4. b. Inner orbits slightly to strongly converging below. d. Labrum over three times as wide as long, apex straight or broadly emarginate with bristles longer than labrum; basal elevated bare zone strong and well defined in female, longer than distal depressed zone, in male not well defined but occupying much of labral surface (for figures, see Toro, 1973a). f. Anterior margin of median ocellus at or behind midpoint between antennal bases and posterior margin of vertex. g. Middle flagellar segments of male a little longer than broad. h. Propodeum with subhorizontal surface about as long as metanotum, which is convex and elevated medially in *L. semicyaneus*; propodeal triangle smooth to transversely wrinkled. i. *Anterior basitarsus of female with comb-like row of hairs on outer margin*. j. Femoral and tibial scopa well developed, blackish. Hairs in front of femoral corbicula with several long branches but main rachis usually surpassing apices of branches; hairs behind femoral corbicula with only few short branches. Tibial scopa with lower hairs not much curved upward, not extending farther below tibia than upper hairs extend above it, lower hairs with several long branches usually surpassed by rachis (Fig. 19g), hairs of upper part with lateral branches conspicuously surpassed by rachis. k. Middle and hind tibial spurs straight to curved, all coarsely pectinate in both sexes of *L. (R.) semicyaneus*, all pectinate in female and finely pectinate in male of *L. bathycyaneus* (illustrated by Toro, 1973a, whose illustrations represent inner and outer *hind* tibial spurs, contrary to the captions). l. Wings hairy throughout but basal halves with hairs sparse and relatively long; three submarginal cells, second usually subequal to or longer than third on posterior margin except in occasional individuals in which second is much shorter than third; second receiving first recurrent vein near middle. m. S2-5 of female with scopa of dusky or blackish somewhat appressed plumose hairs nearly as long as exposed parts of sterna, branches mostly di-

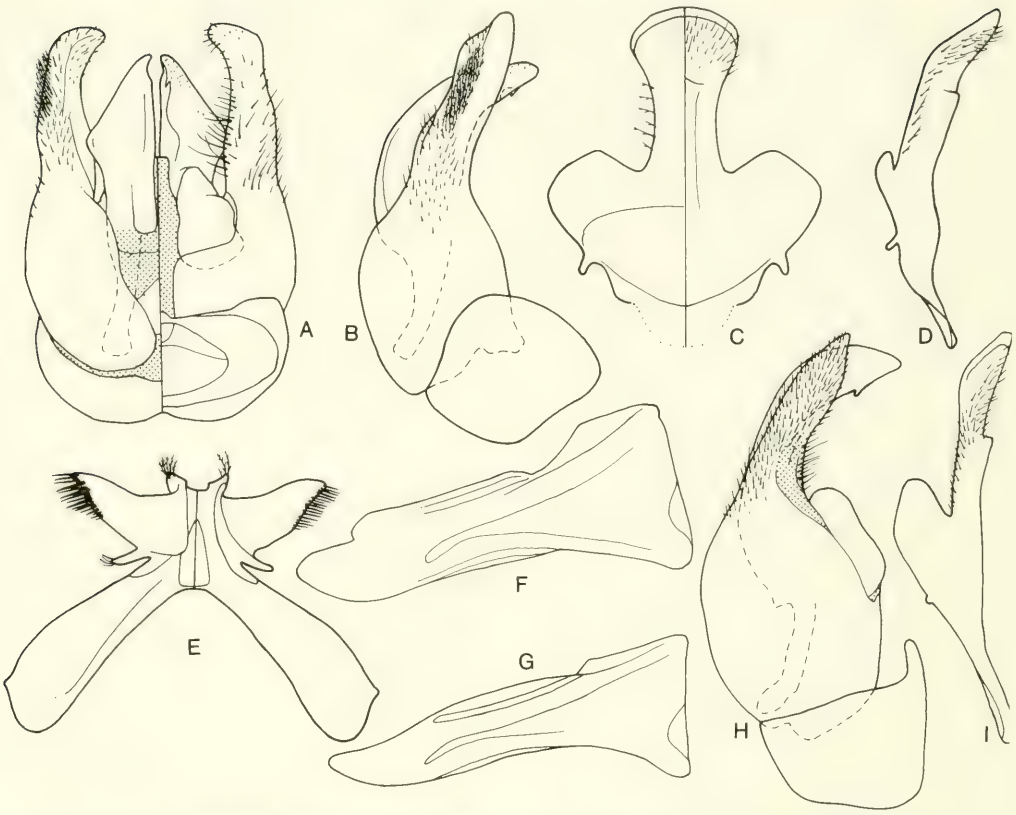

FIG. 14. **a-f.** *Leioproctus (Cephalocolletes) laticeps* (Friese). **a-e.** Genitalia, S8 and S7 of male. **f, g.** Mandibles of female and male. **h, i.** *L. (Reedapis) bathycyaneus* Toro, male, genitalia and S8 (lateral view).

rected apicad (Fig. 19h). S5 of male with long, incurved marginal hairs. n. S7, S8, and genitalia of male as illustrated by Toro (1973a). Gonostylus and gonocoxite fused on dorsal surface but separable on ventral surface, gonostylus about as long as but much more slender than gonocoxite. S7 with lateroapical lobe deeply bifid, or in *L. bathycyaneus* according to Toro (1973a), basal division much reduced. (In a specimen determined by Toro as *L. bathcyaneus*, however, the lobe is divided more or less as in *semicyaneus*; perhaps there are more species.)

Distribution: Central Chile.

Included species: Leioproctus (Reedapis) semicyaneus (Spinola, 1851) [*Colletes*]; *bathycyaneus* Toro, 1973; and **melanocyaneus* Toro, 1973. *Biglossa caerulescens* Friese, 1906, is a synonym of *L. (Reedapis) semicyaneus* (Spinola) and a homonym of *L. (Spinolapis) caerulescens* (Spinola, 1851). This synonymy was omitted by Toro (1973a).

Comments: An unusual feature of *L. semicyaneus* is the presence of two subantennal "sutures" or lines below each antennal base. They converge toward the clypeus and meet just above the upper margin of the clypeus, so that the subantennal area is triangular. It is smooth, impunctate, unlike adjacent parts of the face. The inner line probably represents merely a change in surface sculpture but it is fully as conspicuous as subantennal sutures in many Andrenidae. *L. bathycyaneus* has no such subantennal areas.

The subgeneric name was used (at the genus level) on labels over 30 years ago by Padre J. S. Moure but has not been published. I use *Reedapis* as a patronymic in recognition of Edwyn C. Reed, well known for a study of Chilean bees, plus the generic name *Apis*. Since I have not seen type or authentic material of *L. semicyaneus*, I have designated *L. bathycyaneus* as the type species, although I have no reason to doubt the customary identification of the common species, *L. semicyaneus*.

Cephalocolletes new subgenus

Type species: *Biglossa laticeps* Friese, 1906.

Cephalocolletes differs from *Reedapis* in having the head very broad so that the interocular distance is much greater than the eye length, the eyes scarcely converging below in males and parallel in females, the vertex much enlarged (see character f below), the labrum slightly less than three times as wide as long (with the apex convex in the female), the mandible of the male edentate (Fig. 14g), the female sternal scopal hairs with branches somewhat longer and less numerous than illustrated for *L. bathycyaneus*, and T7 of the male with a longitudinal median bare line. The relationship of *Cephalocolletes* to *Reedapis* is shown by the male genitalia and sterna, the scopa, the large second submarginal cell, etc. (Figs. 14a-g, 16d)

Description: Agreeing with usual (rather than exceptional) characters listed for *Perditomorpha* except as follows: a. Integument and pubescence black. Length 10-16 mm. b. *Inner orbits parallel in female, feebly converging below in male; head unusually broad, interocular distance much greater than eye length.* c. *Clypeal hairs short*, especially in female. d. Labrum nearly three times as wide as long, apex convex in female, weakly emarginate in male, bristles as long as labrum; basal elevated zone strong and well defined in both sexes, longer than distal depressed zone. e. *Mandible simple in male.* f. *Ocelli far from posterior margin of much developed, convex vertex; all ocelli closer to antennal bases than to posterior margin of vertex.* g. Male flagellum with middle segments a little longer than broad. h. Propodeum with horizontal surface a little longer than metanotum. i. *Anterior basitarsus of female with comb-like row of hairs on outer margin.* j. Femoral and tibial scopa as in *Reedapis*. k. Inner hind tibial spur of female with inner margin coarsely pectinate; otherwise spurs finely pectinate (female) to ciliate (male). l. Wings as described for *Reedapis*. m. Exposed sterna and terga as described for *Reedapis* but scopal hairs mostly with longer and less numerous branches than illustrated for *Reedapis* and T7 of male with longitudinal median bare line. n. S7, S8, and genitalia of male as in Fig. 14; S7 with only one large lateroapical lobe on each side, basal lobe greatly reduced.

Distribution: Argentina (provinces of Tucumán, La Rioja, Catamarca and Mendoza). The coarse pollen on the females suggests that this bee is a cactus visitor.

Included species: Leioproctus (Cephalocolletes) laticeps (Friese, 1906) [*Biglossa*]

Comments: Cephalocolletes superficially resembles black species of *Brachyglossula* or even the large black-haired species of *Lonchopria (Biglossa)*; it differs from those groups by the generic characters.

Cephalocolletes and *Reedapis* are the only subgenera of *Leioproctus* with the second submarginal cell rather long compared to the third (except in a few individuals of *Reedapis*). See couplet 3 of the key to subgenera for details. This is a *Lonchopria*-like feature but in other respects these are clearly groups of *Leioproctus*.

Subgenus *Spinolapis* Moure

Pasiphae Spinola, 1851:226 (not Latreille, 1819). Type species: *Pasiphae caerulescens* Spinola, 1851, designated by Sandhouse, 1943:585.

Spinolapis Moure, 1951:193. Type species: *Pasiphae caerulescens* Spinola, 1851, by original designation.

Leioproctus (Spinolapis); Michener, 1965:41.

From the superficially similar *Reedapis, Spinolapis* differs by having only two submarginal cells, by the reduced (or absent) inner tooth on the claws of the female, by the finely pectinate or ciliate tibial spurs, etc. (Figs. 15, 16g; Figs. 136-139, Toro, 1973b)

Description: Agreeing with usual (rather than exceptional) characters listed for *Perditomorpha* except as follows: a. Integument largely metallic blue or head and thorax black. Length 9-12 mm. Head, venter of thorax, and metasoma with much of hair black; metasoma without hair bands. c. Clypeus somewhat protuberant with broad, transverse, shining, sparsely punctate or impunctate, preapical band; basal part flat and closely punctate. d. Labrum as described for *Reedapis* (Fig. 15i, j, and Toro, 1973b for *L. cyaneus* = *cerdai*). e. Maxillary palpus with segments 5 and 6 beyond apex of galea. Mandible with preapical tooth often worn completely away in females. f. Ocelli as described for *Reedapis*. g. Male flagellum reaching at least to scutellum, middle segments about twice as long as broad, or in *L. cyaneus* only reaching tegula and middle segments scarcely 1.5 times as long as broad. h. Propodeum with subhorizontal zone slanting, about as long as or shorter than metanotum, triangle shining or dull and granular in *L. cyaneus*; marginal line not or scarcely pitted. i. Anterior basitarsus of female without or (in *cyaneus*) with comb-like row of hairs on outer margin. *Claws of female simple or (in* L. cyaneus) *with small tooth.* j. Femoral and tibial scopa well developed, pale (in *L. cyaneus*) to black. Femoral scopal hairs rather short, not much curved, those in front of corbicula with two or three long branches but main rachis usually surpassing other branches; hairs behind femoral corbicula almost simple. Tibial scopa with lower hairs not much curved upward, not extending farther below tibia than upper hairs extend above it, lower and outer hairs with a few long branches, some with and others without a rachis surpassing other branches. k. Middle and hind tibial spurs of both sexes straight, ciliate (more coarsely so than in *Perditomorpha* s. str.) or in female of *L. cyaneus*, inner hind tibial spur finely pectinate (see Toro, 1973, as *cerdai* Toro). l. Wing hairs as described for *Reedapis*; two submarginal cells; basal vein meeting or distal to cu-v;

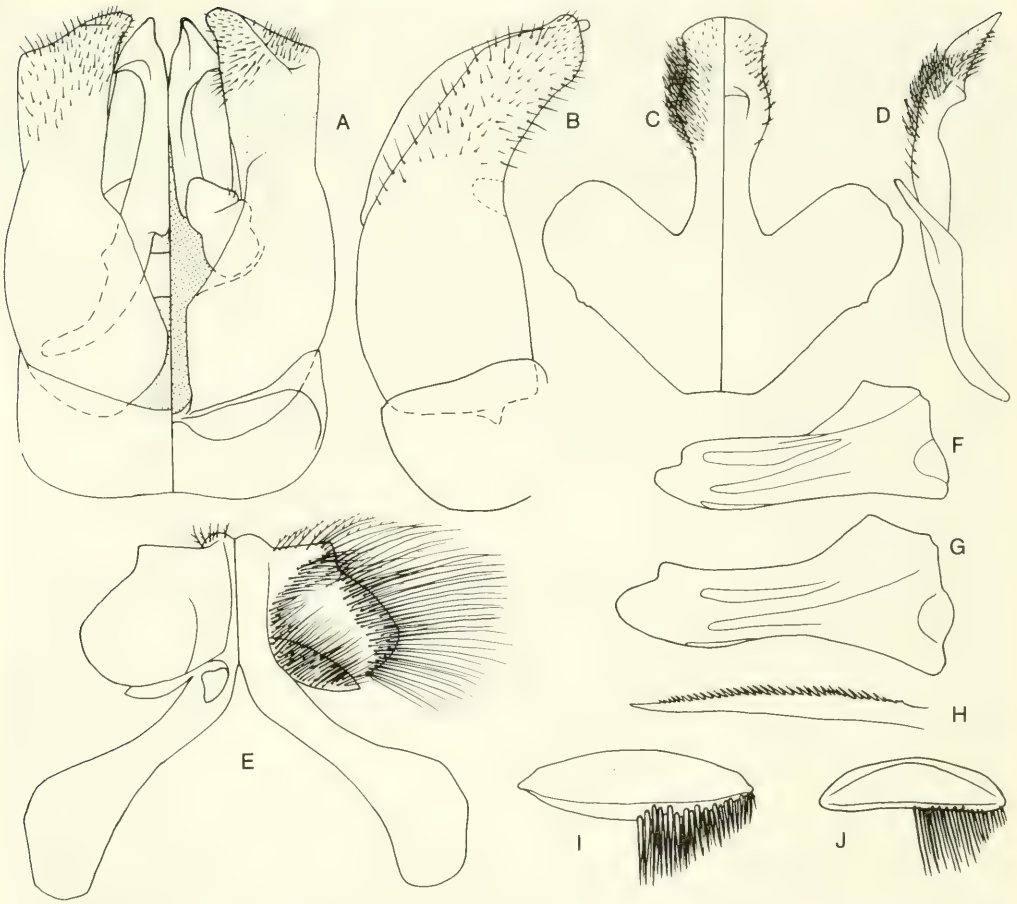

FIG. 15. *Leioproctus (Spinolapis) caerulescens* (Spinola). **a-e.** Genitalia, S8 and S7 of male. **f, g.** Mandibles of male and female. **h.** Inner hind tibial spur of female. **i, j.** Labrum of female and male.

jugal lobe reaching or surpassing level of cu-v. m. S2-5 of female with rather short pollen carrying hairs, shorter than exposed parts of sterna, often somewhat erect, some simple, others with rather short, apically directed branches. S6 of male with narrower midapical lobe than in other subgenera, otherwise unmodified except for apicolateral densely hairy shoulders in *L. caerulescens*. Pygidial plate of male not defined but T7 of male with broad, longitudinal, median hairless ridge which in *L. cyaneus* is broad basally and tapers toward apex like a pygidial plate; apex of T7 densely hairy. Pygidial plate of female narrow and parallel-sided apically. n. S7, S8, and genitalia of male as in Figure 15a-e; in *L. (S.) cyaneus* the two apical lobes on each side of S7 are both broad and rounded, the apical process of S8 is shorter than in *caerulescens*, and the apical half of the gonoforceps is slender.

Distribution: Central Chile and the Lake District of Argentina to Tierra del Fuego.

Included species: Leioproctus (Spinolapis) caerulescens (Spinola, 1851) [*Pasiphae*] and a closely related species. *L. (Spinolapis) cyaneus* (Cockerell, 1915) [*Pasiphae*] (= *L. cerdai* Toro, 1973) and a related species, perhaps *L. (Spinolapis) melanurus* (Cockerell, 1917) [*Pasiphae*], probably belong here. They are smaller and more brightly metallic than the *caerulescens* group; other differences are indicated in the description above. An indication of their relationship to *L. (S.) caerulescens* is the reduced inner tooth of the claw of the female; the tooth is absent in *caerulescens*.

Comments: The sternal scopa of the *L. caerulescens* group is reasonably convincing as a scopa, although the hairs are shorter and more erect than in *Reedapis*. In the *L. cyaneus* group the hairs are still shorter and sparser, although in one of the two females available they are largely covered by a dense mass of pollen, showing that they function as a scopa.

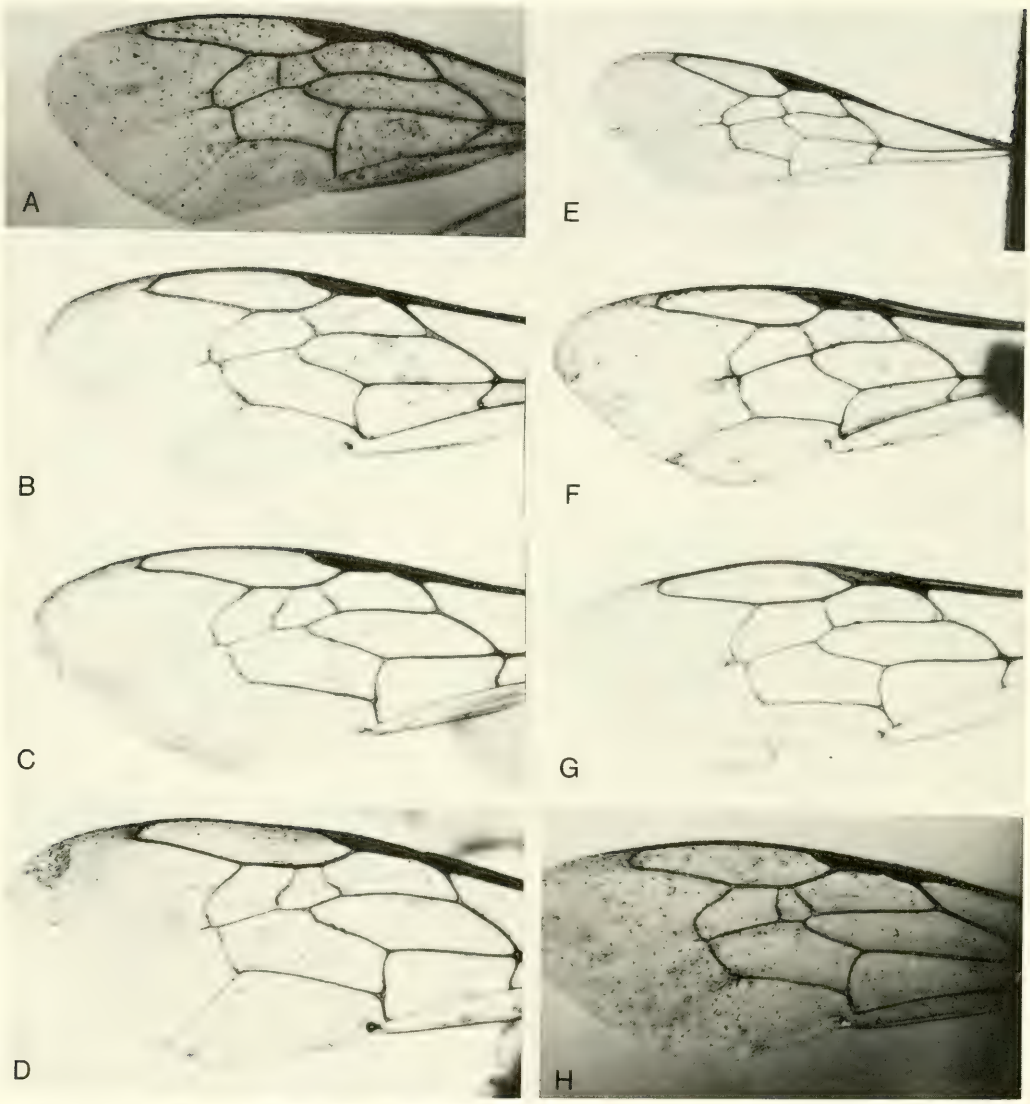

FIG. 16. Forewings. **a.** *Leioproctus (Torocolletes) fazi* (Herbst). **b.** *L. (Hexantheda) missionica* (Ogloblin). **c.** *L. (Reedapis) bathycyaneus* Toro. **d.** *L. (Cephalocolletes) laticeps* (Friese). **e.** *L. (Protodiscelis) palpalis* (Ducke)? **f.** *L. (Tetraglossula) fucosus* n. sp. **g.** *L. (Spinolapis) caerulescens* (Spinola). **h.** *L. (Nomiocolletes) joergenseni* (Friese).

Subgenus *Nomiocolletes* Brèthes

Nomiocolletes Brèthes, 1909:455. Type species: *Nomia jörgenseni* Friese, 1908, by original designation.
Leioproctus (Nomiocolletes); Michener, 1965:41.

In spite of its distinctive appearance due to the enamel-like metasomal bands, *Nomiocolletes* is similar to *Perditomorpha* although with three submarginal cells. The modified hind legs of most males suggest *Pygopasiphae* but are quite different and no doubt independently evolved features. As in *Reedapis, Cephalocolletes*, and some *Spinolapis*, there is a distinct row of hairs on the front basitarsus of the female. (Figs. 16h, 17, 18)

Description: Agreeing with usual (rather than exceptional) characters listed for *Perditomorpha* except as follows: a. Metasoma black, in male broad like that of female (except for *L. simplicicrus*), *posterior margins of T1-4 of female, T1-5 or 6 of male with smooth, hairless, shiny apical bands of enamel-like green, yellowish, or whitish,* punctate and hairy basally in *L. simplicicrus*. Length 10-12.5 mm; 8 mm in *L. simplicicrus*. Pubescence largely pale,

with or without black on vertex and dorsum of thorax; with dusky or black on posterior part of metasoma; not forming pale metasomal hair bands. f. Ocelli in front of summit of convex vertex, anterior margin of median ocellus in front of or near midpoint between antennal bases and posterior edge of vertex. g. Male flagellum reaching middle of tegula, middle segments longer than broad, or in *L. simplicicrus* reaching scutellum with middle segments 1.5 times as long as broad. h. Propodeum with base sloping, much shorter than metanotum, so that profile of propodeum is mostly steeply declivous; propodeal triangle smooth except in *L. simplicicrus*, marginal line pitted or not. i. *Anterior basitarsus of female with well-formed row of hairs along outer margin.* Basitibial plate pointed (both sexes); male with narrow, smooth, shining, hairless ridge from behind basitibial plate to apex of tibia, or in *L. simplicicrus* with strong but hairy carina originating near apex of basitibial plate. j. Femoral and tibial scopa well developed, white or yellow, sometimes

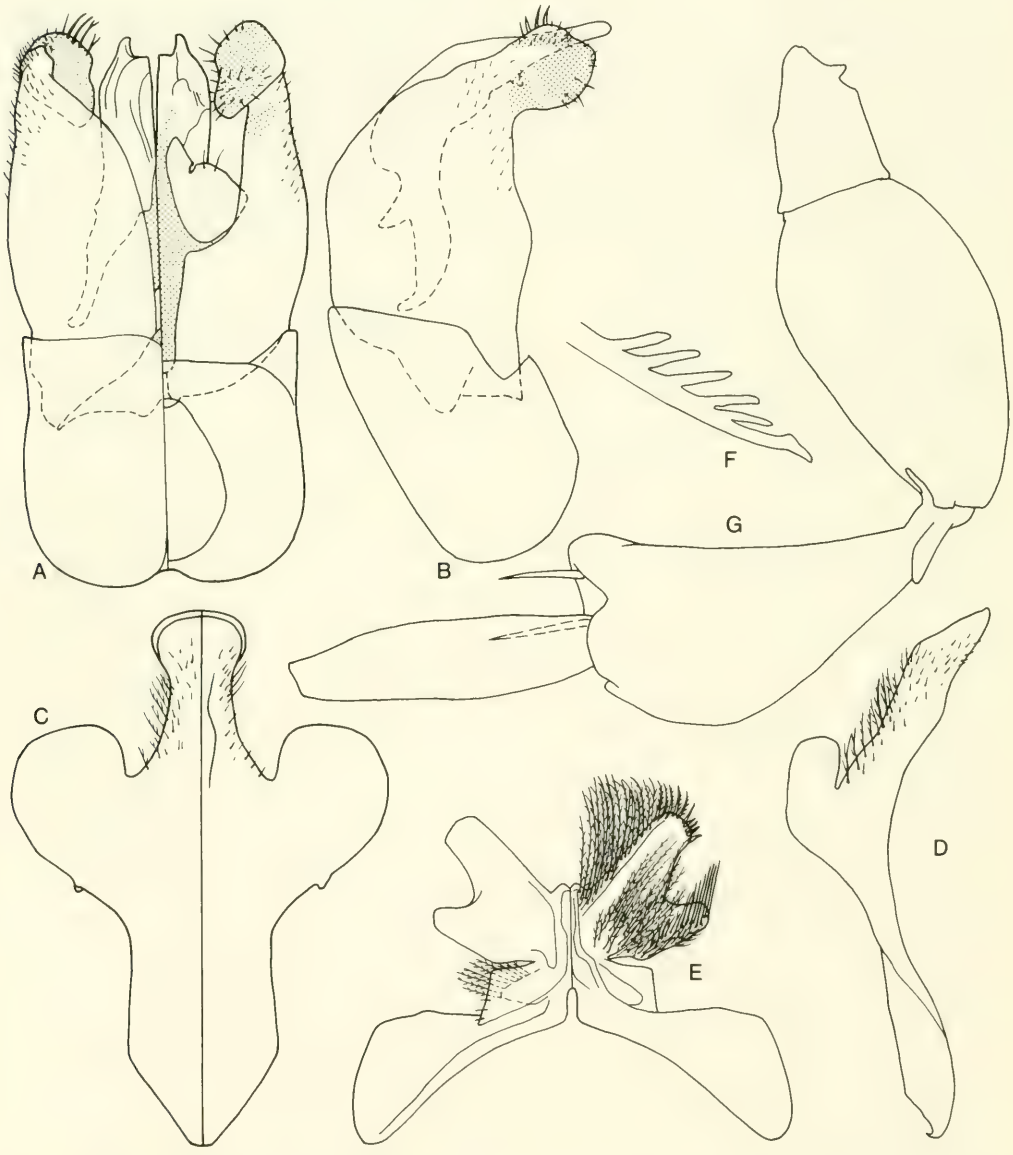

Fig. 17. *Leioproctus (Nomiocolletes) joergenseni* (Friese). **a-e.** Genitalia, S8 and S7 of male. **f.** Inner hind tibial spur of female. **g.** Hind leg of male.

blackish along upper margin of tibia; femoral corbicula with a few hairs arising from its surface; hairs on anterior side of corbicula abundant, long but not curled, form as in *Perditomorpha*; hairs on posterior side of corbicula abundant, mostly simple except for few branched ones adjacent to basal half of corbicula; trochanteral hairs loosely plumose. Tibial scopa well developed, hairs of lower part as in most *Perditomorpha*, grading toward upper margin to hairs with the rachis much exceeding moderately long lateral branches. k. Hind femur of male swollen and hind tibia broadened apically (Fig. 17g) except in *L. simplicicrus* which has slender, unmodified hind legs. l. Wing hairs on basal half of wing longer than on distal part of wing; three submarginal cells, basal vein of forewing meeting or basal to cu-v except distal to cu-v in *L. simplicicrus*; jugal lobe of hind wing reaching level of cu-v or not attaining that level in *simplicicrus*. m. S2-4 of female with apical bands of suberect, mostly simple hairs less than half as long as sterna; S5 with apical band of plumose hairs. S6 of male unmodified, posterior margin with shallow median concavity. T7 of male without pygidial plate, with sparsely hairy, shiny longitudinal median zone which is widest anteriorly, through which runs longitudinal median ridge except in *L. simplicicrus*. n. S7, S8, and genitalia as in Figs. 17, 18. *S7 with three or four lateral apical lobes,* (two in *simplicicrus*), *distal one with coarse apical teeth* (except in *simplicicrus*); process of S8 directed somewhat downward, spiculum rather long, acute; *apex of gonoforceps* (except in *simplicicrus*) *directed downward and mesad, perhaps a gonostylus separated from gonocoxite except on lateral surface, largely membranous.*

Distribution: From Bolivia and central Argentina (Rio Negro) to the northeast of Brazil (Ceará), mostly in xeric areas, with the odd species, *L. simplicicrus*, in Perú.

Included species: Leioproctus (Nomiocolletes) arnaui (Moure, 1949); **cearensis* (Ducke, 1908) [*Nomia*]; **jenseni* (Friese, 1906); *joergenseni* (Friese, 1908) [*Nomia*]; and *simplicicrus* Michener, n. sp.

Comments: As is obvious from the above de-

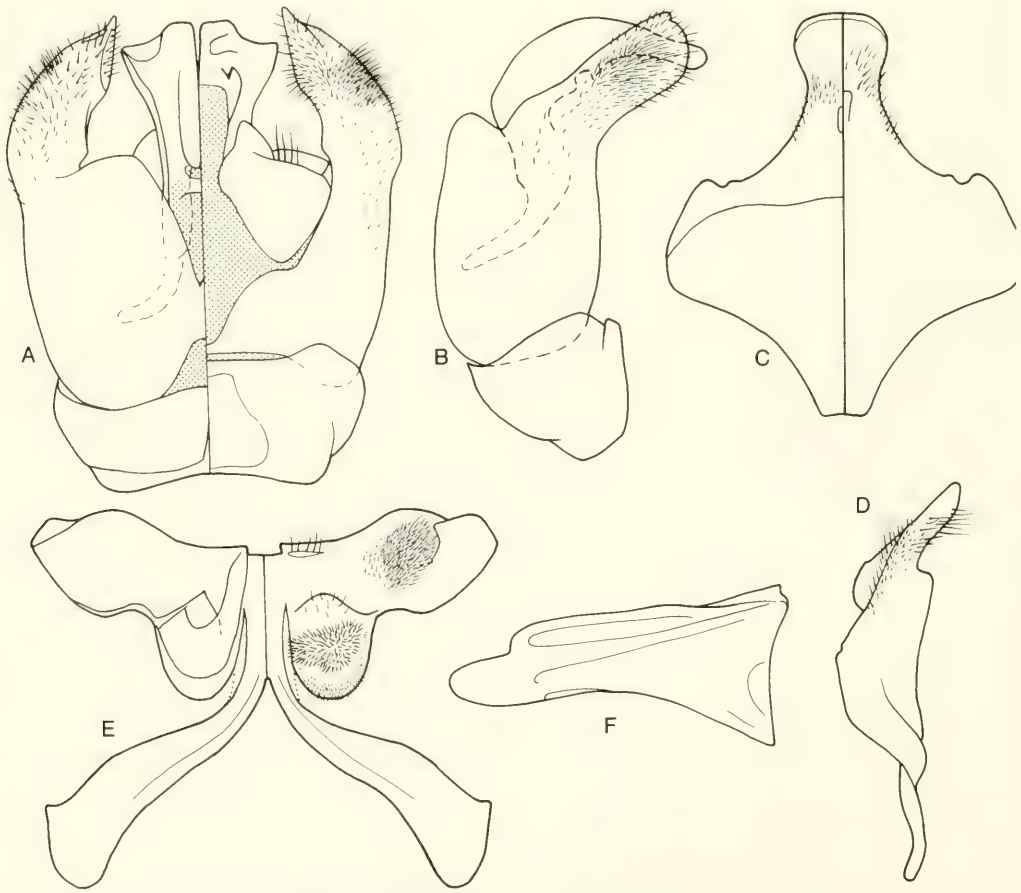

FIG. 18. *Leioproctus (Nomiocolletes) simplicicrus* n. sp., male holotype. **a-e.** Genitalia, S8 and S7. **f.** Mandible.

scription, *L. simplicicrus* is quite different in numerous characters from the other species of the subgenus. The female might further emphasize the difference from other *Nomiocolletes*; it must be noted that in the above description characters recorded for females are based only on the other species for the female of *L. simplicicrus* is unknown. There are enough similarities between that species and the others to suggest that they are sister groups. If one ignores the tergal banding, elaborate S7, and hind tibial carina of the male, characters that indicate its association with *Nomiocolletes, L. simplicicrus* agrees best with such relatively plesiomorphic subgenera as *Chilicolletes*.

Genus *Brachyglossula* Hedicke

Brachyglossa Friese, 1922:577 (not Boisduval, 1829, and others). Type species: *Brachyglossa rufocaerulea* Friese, 1922 (monobasic).

Brachyglossula Hedicke, 1922:427 (replacement for *Brachyglossa* Friese). Type species: *Brachyglossa rufocaerulea* Friese, 1922 (autobasic).

Leioproctus (Brachyglossula); Michener, 1965:41.

This genus of large, dark haired, unbanded bees is distinctive in appearance [except for the superficially similar *Leioproctus (Cephalocolletes) laticeps*]. In some major features such as the vestiture and form of the hind basitarsus of the female and the shape of the process of S8 of the male, *Brachyglossula* resembles *Leioproctus*. The italicized characters in the description are sufficiently marked and unique, however, to support recognition at the genus level even though the result at least for the time being is a paraphyletic

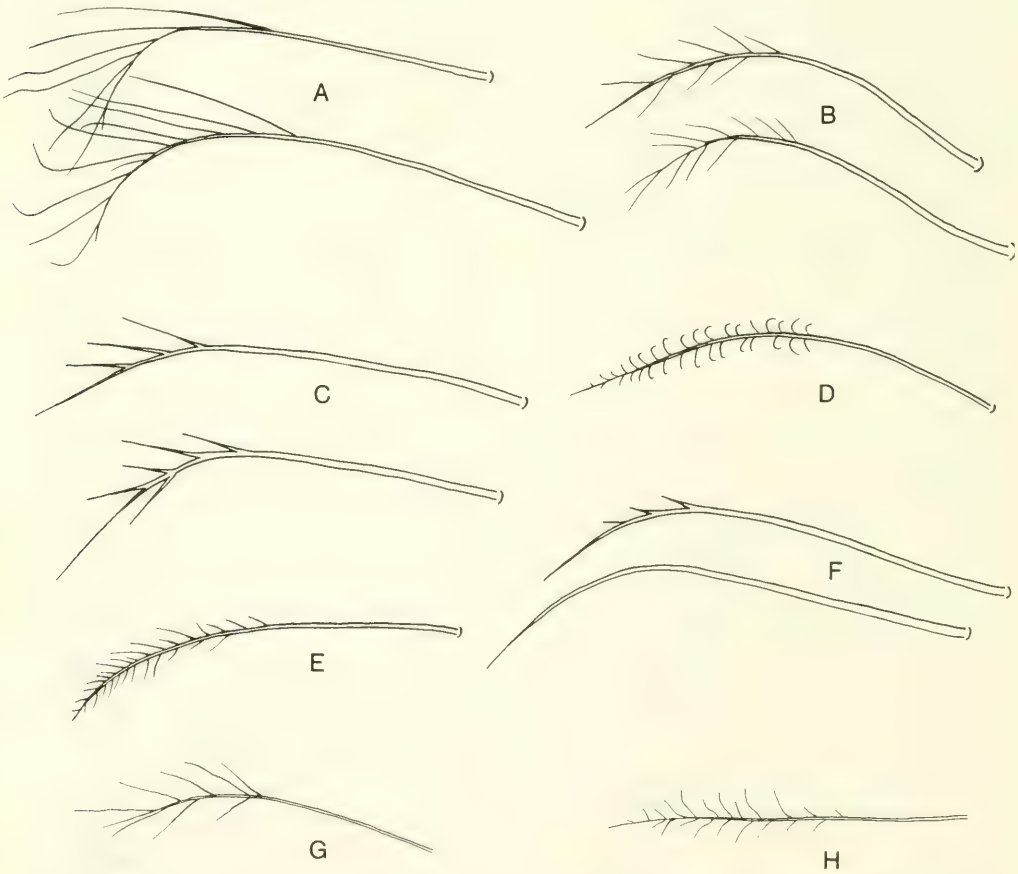

FIG. 19. **a-g.** Hairs from the lower part of the tibial scopa. **a.** *Leioproctus (Perditomorpha) erithrogaster* Toro and Rojas. **b.** *L. (Perditomorpha) brunerii* (Ashmead). **c.** *L. (Leioproctus) fulvoniger* n. sp. **d.** *L. (Glossopasiphae) plaumanni* n. sp. **e.** *L. (Protodiscelis) palpalis* (Ducke)? **f.** *L. (Pygopasiphae) wagneri* (Vachal). **g.** *L. (Reedapis) bathycyaneus* Toro. **h.** Hair from sternal scopa of *L. (Reedapis) bathycyaneus* Toro.

genus *Leioproctus* (see section on Relationships Among Paracolletine Bees). (Figs. 20, 31a)

Description: 1. Integument black or metallic blue, metasoma sometimes red. Length 12-16 mm. Vestiture largely black, metasomal hair bands completely absent. 2. Face rather flat, *supraclypeal area not elevated above frons* or other adjacent areas. *Inner orbits diverging below.* Malar space short. Clypeus somewhat protuberant, punctured throughout. 3. Facial fovea as described for *Lonchopria*. 4. Head often markedly convex both in front of and behind ocelli; vertex convex seen from front; development of vertex behind ocelli variable, so that anterior margin of median ocellus is behind to in front of midpoint between antennal bases and posterior margin of vertex. Preoccipital carina absent. 5. Mandible of female with strong preapical tooth on upper margin, of *male with that tooth broad and weakly to strongly emarginate so that mandible is at least weakly tridentate*. 6. Labrum of female at least four times as wide as long, almost entirely a broad, shiny convexity, *with a strong transverse carina before declivity to depressed margin*; apical depressed margin narrow, apical fringe much longer than labrum. Labrum of male two to three times as wide as long, *smooth, shining, flat or with lateral basal convexities, without usual transverse convexity*; apical margin weakly concave to straight, apical fringe slightly to much longer than labrum. 7. Proboscis without unusual features except long palpi; labial palpus over half as long as prementum; maxillary palpus with last four segments beyond apex of galea. 8. Male flagellum short, reaching pronotal lobe, *middle segments much broader than long*. 9. *Propodeum almost entirely steeply declivous in profile*, only upper margin sometimes slanting; posterior part of thoracic dorsum is the convex metanotum, posterior

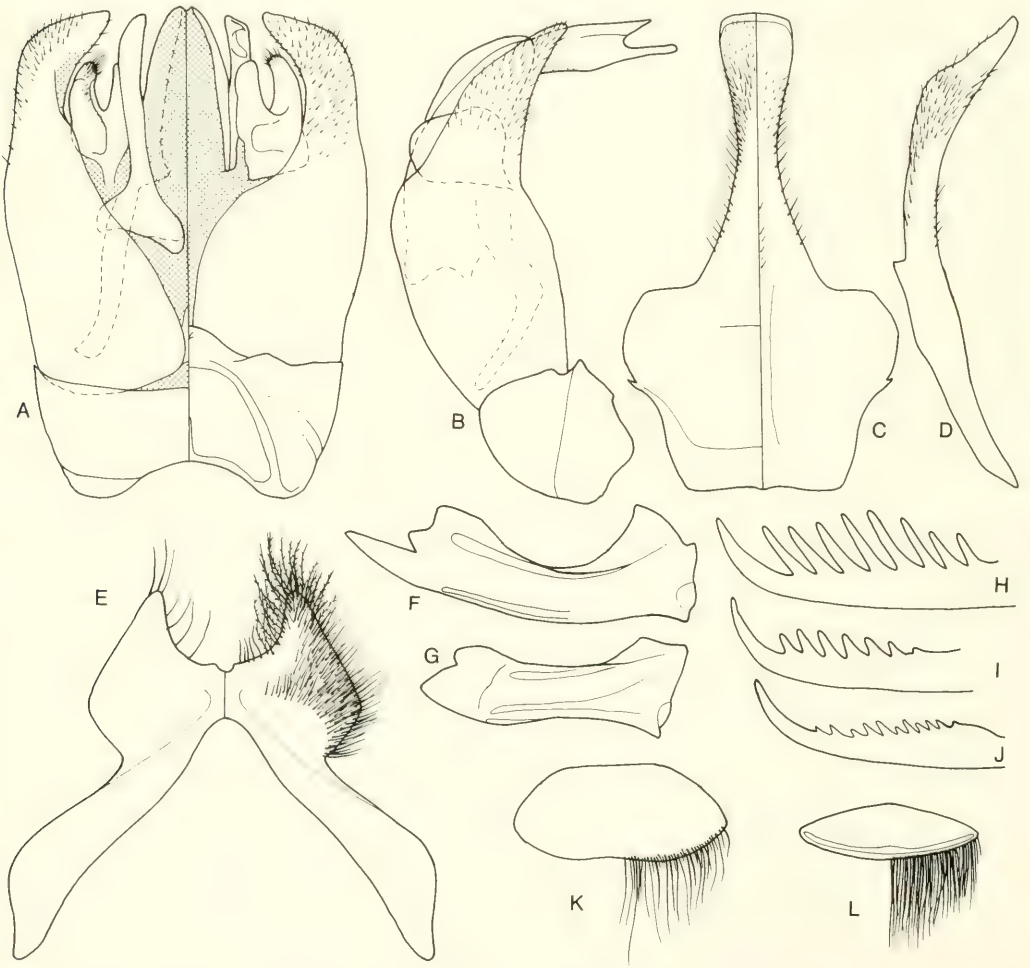

FIG. 20. *Brachyglossula bouvieri* (Vachal). **a-e.** Genitalia, S8 and S7 of male. **f, g.** Mandibles of male and female. **h, i.** Inner hind tibial spur of female, inner and outer margins. **j.** Inner margin of inner spur of male. **k, l.** Labrum of male and female.

margin of which is vertical; propodeal triangle shining, finely roughened, marginal line weakly pitted anteriorly, not pitted posteriorly. 10. Front basitarsus of female hairy, without well developed comb. 11. *Middle and hind tibial spurs strongly curved, coarsely pectinate* with long teeth in female (inner margin of inner hind spur, outer margin of outer hind spur, outer margin of middle spur; other margins coarsely serrate); teeth shorter in male, inner margin of inner hind tibial spur nearly edentate in some males. 12. Femoral and trochanteral scopa not well developed, hairs little longer than femoral diameter; tibial scopa rather short, not hiding surface, longest hairs on lower margin of tibia, these not curled upward or scarcely so; all scopal hairs with strong axes and *fine side branches at more or less right angles to axes* except that posterior to femoral corbicula branches are short, inconspicuous and directed apicad and on upper part of tibial scopa hairs are dense with apically directed branches. Keirotrichia of female of moderate length, well differentiated from other tibial hairs, of male ordinary. 13. Hind basitarsus of female slender, scarcely tapering apically, *apex more than half as wide as width near base*, outer surface rather flat; hairs of outer surface longer than those of inner surface, especially basally. *Hind basitarsus of male scarcely wider than apex of second tarsal segment.* 14, 15. Basitibial plate about one fifth as long as tibia or in males even shorter, defined by carinae, rounded at apex and covered by hair except marginally in female, apex narrowly rounded in male and surface hairy but not hidden; no carina extending apicad. 16. Wings hairy throughout or basal cells partly bare, all hairs minute; two submarginal cells; basal vein meeting or basal to cu-v. Stigma small, costal margin of marginal cell 2.5 to 3 times as long as stigma which is not broader than prestigma (measured to wing margin), *vein r arising well beyond middle*, margin within marginal cell slightly convex. Apex of marginal cell as described for *Lonchopria*. 17. Jugal lobe of hind wing reaching level of cu-v. 18. *T1 markedly narrower than T2*, in female about three fourths and in male two thirds width of T2. S2-5 of female with well developed, dense, plumose scopa, hairs with numerous fine side branches more or less at right angles to axes. 19. S6 of male unmodified, apical margin rounded or with small median emargination. Pygidial plate of male absent but T7 with longitudinal, median, shiny line. Pygidial plate of female with apex narrowly rounded, lateral margins diverging strongly anteriorly, nearly straight. 20-22. S7, S8, and genitalia of male as in Fig. 20. *S7 with a single apicolateral lobe; S8 without usual ventral bump,* apical process as in Leioproctus Group. Gonocoxite attenuate apically, this portion possibly a gonostylus; *volsella vertically expanded, reaching dorsum of genital capsule, deeply bifid in dorsal or ventral view; penis valve strongly curved downward and deeply bifid apically, distal part free from penis which is broadly sclerotized laterally.*

Distribution: Bolivia and Argentina (provinces of Misiones, Jujuy, La Rioja, Catamarca, etc.). Some and perhaps all visit flowers of Cactaceae.

Included species: Brachyglossula boliviensis (Vachal, 1901) [*Pasiphae*], new combination; *bouvieri* (Vachal, 1901) [*Pasiphae*]; *personata* (Cockerell, 1939) [*Pasiphae*]; and *rufocoerulea* (Friese, 1922) [*Brachyglossa*]. There seem to be a few other species, evidently undescribed.

Genus *Niltonia* Moure

Niltonia Moure, 1964:52. Type species: *Niltonia virgilii* Moure, 1964, by original designation.

The extremely long labial palpi are the outstanding feature of this genus but this is by no means a *Leioproctus* with long palpi, as shown by a whole series of other unique features italicized in the description below. (Figs. 21, 31b; Fig. 1, Moure, 1964; Figs. 1-3, Laroca and Almeida, 1985).

Description: 1. Integument black, nonmetallic. Length 10-12.5 mm. Vestiture of female largely black, of male mostly gray, metasomal hair bands completely absent. 2. Supraclypeal area not much elevated above frons or clypeus. Inner orbits converging below. Malar space short. Clypeus convex, protuberant (less than eye width), punctured throughout. 3. Facial fovea as described for the Lonchopria group. 4. Head strongly biconvex in front of ocelli; vertex convex behind ocelli and seen from front; anterior margin of median ocellus behind midpoint between antennal bases and posterior margin of vertex. Preoccipital carina absent. 5. Mandible with preapical tooth on upper margin. 6. Labrum about four times as wide as long with strong median elevation over one third as wide as labrum in female, less than one third as wide in male; apical margin feebly convex, apical fringe much longer than labrum. 7. Proboscis short, galea rounded at apex, glossal lobe much shorter than basal width; *labial palpus enormous, 8-9 mm long, in repose reaching S3 or S4, fourth segment much longer than first three together, tapering, often extended beyond apex of metasoma, irregularly toothed* (Fig. 1 of Moure, 1964; Fig. 3 of Laroca and Almeida, 1985); maxillary palpus with last three segments beyond apex of galea. 8. Male flagellum short, reaching pronotal lobe, middle segments longer than broad. 9. Propodeum mostly steeply declivous in profile but with slanting basal zone shorter than metanotum; propodeal triangle finely roughened, marginal line not pitted. 10. Front basitarsus of female hairy, except under side abruptly only sparsely so, no well developed comb. 11. Middle and hind tibial spurs robust, curved, with numerous fine teeth, finer in male than female, longest on inner margin of inner hind spur and outer margins of middle and outer hind spurs; *inner hind tibial spur much longer than outer.* 12. Scopa on leg rather

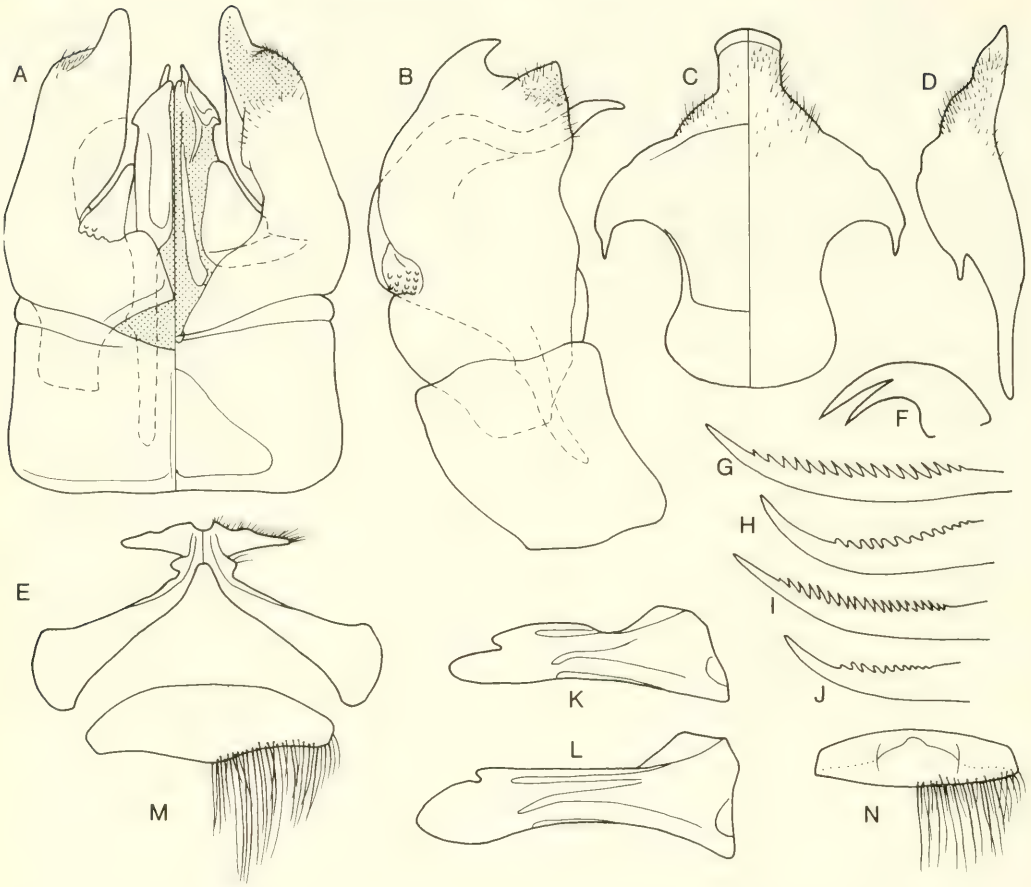

FIG. 21. *Niltonia virgilii* Moure. **a-e.** Genitalia, S8 and S7 of male. **f.** Claw of male. **g, h.** Inner and outer hind tibial spurs of female. **i, j.** Same, of male. **k, l.** Mandibles of male and female. **m, n.** Labrum of male and female.

short, hairs with major branches such that there is no distinct rachis distally except on upper part of tibia; hairs behind femoral corbicula with few branches, many merely bifid; lower hairs of tibial scopa curved distad but not upward. Keirotrichia of moderate length, well differentiated from other hairs. 13. Hind basitarsus of female slender, slightly tapering apically, apex more than half as wide as width near base, outer surface flat; hairs of outer surface longer than those of inner surface. *Hind basitarsus of male only slightly wider than apex of second tarsal segment. Claws* (both sexes) *with inner and outer rami similar in shape, slender, of almost equal length, so that claws are deeply bifid.* 14, 15. Basitibial plate a little less than one third as long as tibia in female, one fourth in male, defined by carinae, almost pointed, with short hairs not obscuring surface; male with strong ridge, almost a carina but hairy, from apex of basitibial plate to apex of tibia. 16. Wings minutely hairy throughout; two submarginal cells; basal vein meeting or slightly distal to cu-v. Stigma rather small, costal margin of marginal cell over twice length of stigma which is not broader than prestigma (measured to wing margin), *vein r arising well beyond middle,* margin within marginal cell convex. Apex of marginal cell as described for the Lonchopria group. 17. Jugal lobe of hind wing exceeding level of cu-v. 18. S2-5 of female with well developed scopa of hairs that have several long branches so that there is no clear rachis apically. 19. *S6 of male with median, broad, shallow, shining, impunctate concavity; apical margin shallowly emarginate. T7 of male with triangular pygidial plate, sharply pointed apically, margined by carinae laterally.* Pygidial plate of female rounded apically. 20-22. S7, S8, and genitalia of male as in Fig. 20a-e and Fig. 1 in Laroca and Almeida (1985). *S7 with a single apicolateral lobe* plus small basal membranous lobe, hairs on these lobes marginal, i.e., neither dorsal nor ventral; *S8 without usual ventral bump; apical process extremely short,* terminating as in Leioproctus group. *Apex of gonoforceps bilobed; volsella with apex expanded dorsally, reaching dorsum of genital*

capsule; penis valve strongly curved downward at apex, apodemes of penis valves parallel, not curved upward proximally; penis with long sclerotic strips on lower surface.

Distribution: Brazil, states of Santa Catarina to Rio de Janeiro.

Included species: Niltonia virgilii Moure, 1964.

Comments: In certain features *Niltonia* resembles *Brachyglossula*. The dorsally expanded volsellae and the distal origin of vein r on the stigma are the most apparent such characters. Perhaps both genera arose from a common ancestor within the Leioproctus group.

Lonchorhyncha new genus

Type species: *Diphaglossa ecuadoria* Friese, 1925.

The elongate clypeus and malar area (about as long as the eye) led to placement of this bee in the genus *Diphaglossa* (subfamily Diphaglossinae) where it has remained until now. No other American paracolletine has such a head. Other characters quite unlike *Leioproctus* include those of S7, S8, and the genitalia of the male, as described below. The two ventral prongs on the penis valve suggest *Lonchopria* s. str. but other characters do not indicate a close relationship to that taxon. (Figs. 22a-i, 23a-d, 31c)

Description: 1. Nonmetallic, metasomal hair bands and integumental color bands absent. Punctation mostly fine and weak but surface, especially of head and thorax, minutely roughened and dull. 2. Face protuberant and extremely *produced; upper margin of clypeus below lower ends of eyes*; supraclypeal area (measured to lower margins of antennal sockets) over half as long as clypeus, longer than wide, not elevated above level of clypeus but strongly elevated above frons and paraocular area, frontal tubercle strong. Orbits subparallel in female, converging below in male. *Malar space nearly as long as eye in female, slightly longer than eye in male.* Clypeus convex with longitudinal median flat or slightly depressed zone but no differentiated depressed area as in most *Lonchopria*. 3. Facial foveae not recognizable although surface mesal to upper part of eye broadly concave. 4. Vertex extending only an ocellar diameter or less behind ocelli, *seen from front not broadly convex, laterally* (between ocelli and eye) *concave and lower than summit of eye,* medially a little elevated, bearing ocelli slightly higher than summit of eye. Distance from anterior margin of median ocellus to posterior margin of vertex about half of distance to antennal sockets. 5. Mandible of female short, slender medially but broadened apically, cap of rutellum large, preapical tooth on upper margin; of male slender, almost parallel sided except for broader base, with preapical tooth on upper margin. 6. Labrum of female unknown. Labrum of male over twice as wide as long; apical margin straight medially, with long bristles; rest of labrum thickened, irregularly roughened, hairless. 7. Proboscis long but otherwise not unusual, stipes about three fourths as long as head; galeal comb of 15 bristles; apices of galeae broken off in only specimens so that length is unknown; maxillary palpus about half as long as stipes, of six subequal segments; glossa shallowly emarginate, lateral lobe about as long as broad; labial palpus over two fifths as long as prementum, segments subequal in length. 8. Antenna of male reaching base of scutellum, flagellar segment $1 < 2 + 3$, nearly twice as long as broad, 2 about as long as broad, segments 3-9 ranging from less than 1.5 (seg. 3) to over 1.5 (seg. 9) times as long as wide, segment 10 over twice as long as wide. Antenna of female reaching tegula, flagellar segment 1 equal to $2 + 3$, over twice as long as wide, 2 slightly broader than long, remaining segments about 1.5 times as long as broad except segment 10 which is twice as long as broad. 9. Propodeal triangle minutely roughened, nearly dull, marginal grooves not pitted, *profile nearly vertical*, dropping from posterior margin of metanotum which is convex but largely declivous. 10. Front basitarsus of female, on outer margin with weakly differentiated comb of hairs or bristles longer than other basitarsal hairs, hairs of comb well separated (i.e., not closely placed), tapering, curved. 11. *Inner hind tibial spur of female pectinate with about 10 teeth, the middle ones longest, bases well separated*; of male ciliate with many fine, rather long teeth, some nearly as long as diameter of spur. 12. Femoral scopa weak; long, rather dense, straight, loosely plumose hairs present on underside of hind trochanter and base of femur; rest of femur with only short sparse hairs on lower surface, simple on distal half; long, branched, downcurved hairs on anterior surface of female partially enclose femoral corbicula. Hind tibia (female) with long branched hairs of lower surface curved outward and upward, along with hairs of outer surface forming a strong scopa which is not so dense as to fully obscure the tibial surface; hairs of inner surface simple, moderately long, not forming zone of short keirotrichia. 13. Hind basitarsus of female slender with outer surface convex, hairs longer, finer, and sparser than those of inner surface, mostly simple but those near basal half of upper margin plumose like those of tibial scopa, not obscuring surface. 14. Basitibial plate of female well defined, strongly elevated, with shining, marginal carina; apex narrowly rounded, almost pointed; surface largely hidden by abundant short hairs. Claws with strong inner tooth. 15. Basitibial plate of male similar to that of female but hairs not hiding surface; no carina. 16. Wings hairy throughout. Basal vein slightly distal to cu-v. Stigma slender, as wide as prestigma (measured to wing margin), vein r arising near middle, margin within marginal cell slightly convex. Three submarginal cells, second and third subequal in length measured either on anterior or posterior margins. Apex of marginal cell narrowly rounded or

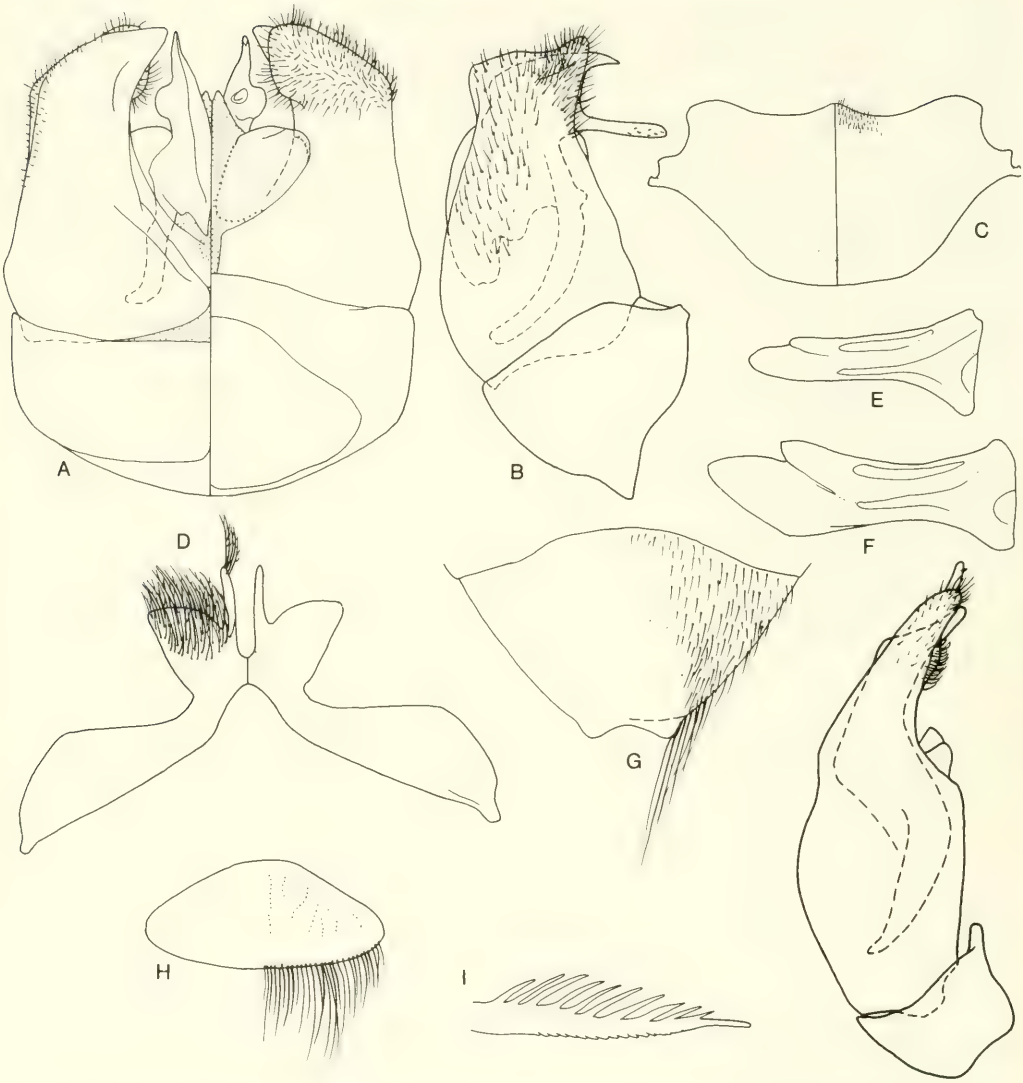

FIG. 22. **a-i.** *Lonchorhyncha ecuadoria* (Friese). **a-d.** Genitalia, S8 and S7 of male. **e, f.** Mandibles of male and female. **g.** T7 of male. **h.** Labrum of male. **i.** Inner hind tibial spur of female. **j.** *Eulonchopria punctatissima*, male genitalia.

pointed, separated from costal margin by three or four vein widths. 17. Jugal lobe of hind wing half as long as vannal, only two thirds as long as cell Cu, far short of level of cu-v. 18. Metasomal sterna with hair of moderate length, sparser and shorter posteriorly in male. 19. Pygidial plate of male represented by large, slightly concave, hairless area, not sharply defined except for apical emarginate flange which extends slightly beyond morphological posterior tergal margin. 20. S7 of male moderately narrowed medially, *flat, with one pair of apical hairy lobes*, each lobe with mesal, posteriorly directed process. 21. *S8 of male weakly sclerotized, almost quadrate, without apical process* and without spiculum. 22. Male genitalia without distinct gonostylus, gonoforceps robust. *Volsella largely membranous, weakly sclerotized only laterally*, without denticles. Penis valve compressed, downcurved at apex and with long median process projecting downward.

Distribution: Ecuador.

Included species: Lonchorhyncha ecuadoria (Friese, 1925). An account of the species is included in the Appendix.

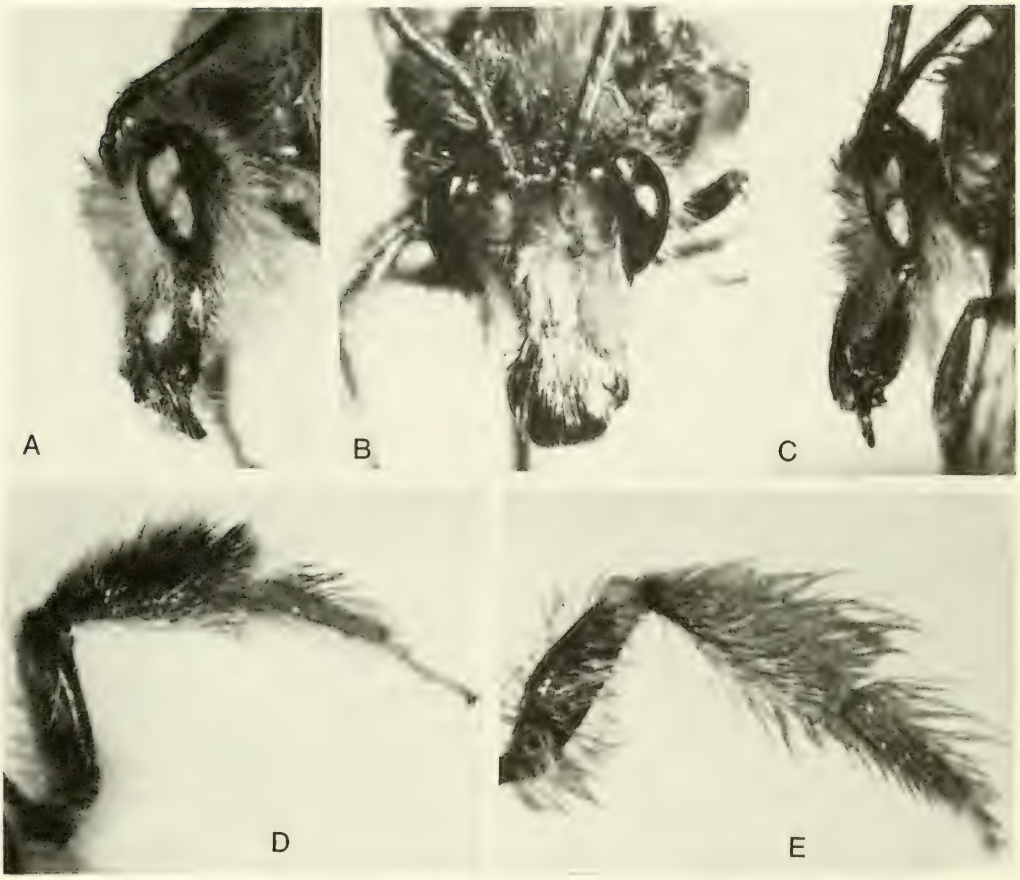

FIG. 23. **a-d.** *Lonchorhyncha ecuadoria* (Friese). **a.** Head of female (type). **b, c.** Head of male. **d.** Outer side of hind leg of female. **e.** Outer side of hind leg of female, *Leioproctus (Kylopasiphae) pruinosus* n. sp.

Genus *Eulonchopria* Brèthes

This is a genus of coarsely punctured and sculptured bees with yellow integumental bands on some of the metasomal terga and often plaited forewings with darkened costal margins so that there is a superficial resemblance to eumenid wasps. The many unique features are italicized below.

Description: 1. Body nonmetallic, *largely coarsely punctate and coarsely sculptured; pubescence short,* in *Eulonchopria* s. str. at anterior and posterior scutal angles and often elsewhere hairs so short that each fits within a puncture and is broadly plumose. Metasomal hair bands absent but some terga with *apical integumental pale yellow bands in depressed marginal zones*. Length 7-11 mm. 2. Face convex, supraclypeal area more protuberant than clypeus. Orbits converging below. Malar space very short. 3. Facial fovea absent or deeply impressed, well defined in both sexes, elongate, low on face (not reaching summit of eye). 4. Vertex convex and elevated far above upper ocular tangent seen from front. Anterior margin of median ocellus near or in front of midpoint between antennal bases and posterior margin of vertex. *Preoccipital carina strong, often lamella-like.* 5. Mandible (male and female) with preapical tooth on upper margin. 6. Labrum much broader than long with apical margin convex. 7. Proboscis without unusual features; labial palpus about one third as long as prementum; maxillary palpus with last one to two segments extending beyond apex of galea. 8. Antenna of male reaching scutellum, middle flagellar segments usually less than twice as long as broad. 9. *Pronotum dorsolaterally with strong transverse carina or lamella extending onto lobe. Metepisternal area deeply impressed and almost hairless. Propodeal triangle with large, deep pits; some ridges margining pits produced, lamella-like or tooth-like.* Horizontal base of propodeum as long as or shorter than metanotum, less than one third as long as vertical surface in profile, *horizontal and vertical surfaces separated by sharp angle* or lamella.

10. *Front basitarsus of female with outer apical process* from which comb extends basad on outer edge of basitarsus. 11. Inner hind tibial spur of female coarsely pectinate (3 to 5 teeth); of male coarsely toothed or ciliate or hind tibial spurs completely absent. 12. Femoral scopa of rather short, curved hairs *densely plumose toward apices*. Hind tibia with hairs of outer surface short and not scopa-like, especially on distal half of tibia*, hairs of lower margin and inner surface longer, on inner surface (except basally) not plumose but not forming zone of short keirotrichia. 13. Hind basitarsus of female elongate, tapering, apex more than half as wide as maximum width near base, outer surface slightly concave below upper margin; hairs as long as or shorter than those of inner surface, not very different from those of outer surface of tibia, not obscuring surface. 14. Basitibial plate of female well defined, pointed or rounded apically, *about one third as long as tibia*. 15. Basitibial plate of male well defined, carina extending to apex of tibia. 16. *Forewing commonly folded longitudinally (as in Vespidae)* (see Danforth and Michener, 1988). Basal vein distal to or meeting cu-v. Stigma nearly parallel sided, *vein r arising near apex* and part of margin within marginal cell oblique, not convex. Three submarginal cells. Apex of marginal cell obliquely bent away from wing margin or obliquely truncate. 17. Jugal lobe of hind wing variable. 18. Metasomal sternal hairs (both sexes) usually extremely short. *Prepygidial fimbria of female strongest medially, fading away laterally.* * 19. *Pygidial plate of female with margin continued basolaterally nearly to lateral margin of T6, isolating depressed area on which pygidial fimbria arises.* Pygidial plate of male absent, *surface of T7 extremely coarsely punctate* (like preceding terga). 20. S7 of male narrow medially, with two or three pairs of broad lobes distally, *these lobes bent so that hairs are on ventral surfaces*. 21. S8 of male rather large and broad, with broad basal spiculum and broad apical region, sometimes continued as small apical process which is flat, not beveled like a pygidial plate, at apex. 22. *Male genitalia sometimes with distinct slender gonostylus.* Volsella small, without distinct denticles. Penis valve not strongly downcurved apically, with preapical lobes or processes on inner margin.

Distribution: Arizona to Argentina, mostly in xeric or savanna areas. It occurs principally from central Brazil to Argentina and Bolivia and from Oaxaca through western Mexico to Arizona. It has also been collected in Nicaragua and Venezuela. It is the only paracolletine in North America.

Comments: Characters marked by an asterisk in the above description have not been verified for the subgenus *Ethalonchopria*.

This is a genus of remarkable bees, with numerous distinctive characters italicized above. Most of these characters are unusual among bees, not shared by potential outgroups (*Leioproctus* and Colletidae other than Paracolletini) and are apomorphies. The deep, rather slender, bare, well defined facial foveae (one subgenus), however, are shared with the Australian paracolletine *Callomelitta* and with other colletid subfamilies such as Hylaeinae. This is probably a plesiomorphy. Likewise the distinct, slender, male gonostyli of some species, unique for the Colletidae, are a possible plesiomorphy. Its apparently disjunct distribution (absent in wet tropics) combined with its unusual characters and the diversity of the species suggest that *Eulonchopria* is an archaic group that possesses many specialized features.

Recent studies of the genus are by Michener (1963, 1985). Genitalia and hidden sterna of males are illustrated in the first paper listed. An additional illustration of genitalia is included herein to provide a needed lateral view.

KEY TO THE SUBGENERA OF *EULONCHOPRIA*

1. Facial fovea absent; anterior and lateral surfaces of mesepisternum not separated by carina . . . . . *Ethalonchopria*
—. Facial fovea distinct; anterior and lateral surfaces of mesepisternum separated by carina. . . . . *Eulonchopria* s. str.

Ethalonchopria new subgenus

Type species: *Apista gaullei* Vachal, 1909.

This subgenus differs in many features from the other subgenus. In nearly all of the subgeneric characters it is less strange than *Eulonchopria* s. str., i.e., more like other paracolletines. Noteworthy are the punctate and only slightly concave foveal areas on the face, so that distinct foveae are absent, and the simple axillae. (Michener, 1985, Fig. 1)

Description: a. Facial fovea absent. b. Preoccipital carina strong but not a lamella. c. Ridge mesal to posterior ocellus absent. d. Base of labrum convex in female, binodulose in male. e. Margin of dorsolateral pronotal carina straight. f. Anterior and lateral surfaces of mesepisternum not separated by carina. g. Axilla not produced and angulate posteriorly. h. Margins of basitibial plate largely hidden by hair in female; carina on upper margin of hind tibia of male not toothed. i. First submarginal cell longer than second plus third (measured on posterior margins), second very small. Basal vein of forewing meeting cu-v. j. Jugal lobe of hind wing extending little more than half way from base to level of cu-v. k. Apex of T7 of male entire.

Distribution: Bolivia; Santa Catarina, Brazil.

Included species: Eulonchopria (Ethalonchopria) gaullei (Vachal, 1909) and *limbella* (Vachal, 1909),

which may be the same species (see Michener, 1985).

Comments: The above description is based on a single male from Santa Catarina, Brazil, kindly loaned by T. L. Griswold [Logan] and on my earlier observations of the female types (the only known specimens) of the two nominal species from Bolivia (Michener, 1985). No females were available for supplementary observations. The male is clearly a member of this subgenus but its species is uncertain since there are no associated females.

Etymology: The subgeneric name is based on the Greek *ethas*, ordinary, plus the generic name *Lonchopria*, with reference to the fact that these are more ordinary bees than the other *Eulonchopria*.

Subgenus *Eulonchopria* Brèthes s. str.

Eulonchopria Brèthes, 1909:247. Type species: *Eulonchopria psaenythioides* Brèthes, 1909 (monobasic).

This subgenus contains the more ornate and extraordinary members of the genus. The carinate mesepisterna and produced and angulate axillae are unique among Paracolletinae. (Fig. 22j; Figs. 1-15, Michener, 1963; Fig. 3, Danforth and Michener, 1988)

Description: a. Facial fovea of female distinct. b. Preoccipital carina forming a strong lamella. c. Brow-like ridge mesal to posterior ocellus distinct to absent. d. Base of labrum binodulose. e. Margin of dorsolateral pronotal carina convex. f. Anterior and lateral surfaces of mesepisternum separated by angle that is carinate above. g. Axilla slightly produced and angulate posteriorly. h. Margins of basitibial plate fully exposed in both sexes; carina on upper margin of hind tibia of male toothed. i. First submarginal cell about as long as second plus third (measured on posterior margins). Basal vein of forewing beyond cu-v. j. Jugal lobe of hind wing nearly attaining level of cu-v. k. Apex of T7 of male bilobed or bidentate.

Distribution: Argentina (Tucumán Province) and Paraguay to Brazil (states of Santa Catarina to Minas Gerais); Venezuela; Nicaragua; Mexico (states of Oaxaca to Sonora), U.S.A. (southern Arizona). Floral records on labels and my observations near Chamela, Nayarit, Mexico, indicate that *E. punctatissima* and *oaxacana* may be oligolectic visitors to flowers of *Acacia*.

Included species: Eulonchopria (Eulonchopria) oaxacana Michener (1963), *psaenythioides* Bréthes (1909), and *punctatissima* Michener (1963). There appear to be additional South American species.

Comments: Eulonchopria s. str. contains two species groups. In the South American *E. psaenythioides* and its undescribed relatives the hind tibial spurs of the male are present, the brow-like ridge mesal to the posterior ocellus is strong, S8 of the male lacks an apical process, and there are no slender male gonostyli. In the two North American species, *E. punctatissima* and *oaxacana*, the hind tibial spurs of the male are absent, the brow-like ridge mesal to the posterior ocellus is weak to absent, S8 of the male has a small, apically expanded process, and there is a slender, well defined genital process, probably the gonostylus.

Genus *Lonchopria* Vachal

The very dense tibial scopa of the female, contrasting with short, sparse, simple or restrictedly plumose hairs on the outer side of the hind basitarsus, is the most striking distinction from other American paracolletines. *Lonchopria (Lonchoprella)* is an exception to this character, however. Other characters italicized below also distinguish *Leioproctus* and *Lonchopria*. Males of *Lonchopria* differ from those of *Leioproctus* in the lack of a beveled apex of the process of S8. In *Leioproctus* the apex of the process of S8 is exposed, beveled, and superficially resembles a pygidial plate. The subgenus *Ctenosibyne*, which clearly is related to the subgenus *Lonchopria*, has an apex of the process of S8 that seems suggestive of that of *Leioproctus*. It is, however, broad, thin, and hairy, as in some species of the subgenus *Biglossa*, and is in reality not like that of *Leioproctus*.

Description: 1. Integument black or metallic bluish, metasomal hair bands present or absent, terga without colored integumental bands. Length 7-15 mm. 2. Face flat to moderately convex, supraclypeal area not much elevated above clypeus but elevated above frons. Inner orbits converging below. Malar space very short. *Clypeus commonly with depressed, median closely punctate area, lateral and distal to which are more shining convex areas* (not so in *Lonchopria* s. str.). 3. Facial fovea not recognizable or indicated only by broad, undefined area of slightly different texture than rest of face. 4. Vertex weakly convex seen from front to strongly convex and elevated well above upper ocular tangent. Anterior margin of median ocellus variable in position. Preoccipital carina absent. 5. Mandible of female and most males slender with preapical tooth on upper margin (two such teeth in male of one species of subgenus *Biglossa*), *commonly with apex in male broadened by expansion of lower margin or with process on lower margin*. 6. Labrum variable, usually less than three times as wide as long. 7. Proboscis without unusual features or glossa moderately [*L. (Biglossa) robertsi*] to greatly (*Porterapis*) elongate and deeply bifid; labial palpus about one third as long as prementum (longer in *Lonchoprella*); maxillary palpus with little more than last segment (if any) extending beyond apex of galea, which is short (or most of last two segments exceeding galea in *Lonchoprella*). 8. Antenna of male reach-

ing tegula or beyond, middle flagellar segments 1.5 to over 2 times as long as broad. 9. Propodeal triangle smooth or finely transversely wrinkled, dull to shining; base of propodeum sloping, shorter than or equal to metanotum, curving onto declivous surface, about one third as long as declivous surface in profile. 10. Front basitarsus of female with comb of hairs on outer margin. 11. Inner hind tibial spur of female pectinate with *four to eight very long teeth, their bases about as close as they can be so that they diverge from a sometimes somewhat thickened part of spur*; of male ciliate with many fine and somewhat elongate teeth. 12. Femoral scopa of abundant, long hairs with numerous fine side branches, *femoral corbicula closed basally by similar long, curved, plumose hairs arising on trochanter* almost like floccus of *Andrena*. Hind tibia (female) with hairs of lower surface curled outward and upward, along with hairs of outer surface forming dense scopa of long, branched hairs usually entirely obscuring tibial surface, many of hairs lacking a single strong rachis but with several branches of more or less equal length, as in *Leioproctus (Perditomorpha)* (Fig. 19a) but often with more branches; hairs of inner surface of hind tibia simple, moderately long to long, not forming zone of short keirotrichia. (*Lonchoprella* is an exception to most scopal characters; see description below.) 13. *Hind basitarsus of female tapering toward extreme apex which is only about half as wide as width near base. Hind (also middle) basitarsus of female with outer surface usually slightly longitudinally concave below upper margin, vestiture entirely different from that of tibia, hairs short, not longer than those of inner surface* [or slightly longer in *L. (Biglossa) nivosa* and *Lonchoprella*], not obscuring surface. (Hairs of upper margin of hind basitarsus long, not to be confused with those of outer surface). 14. Basitibial plate of female well defined but often hidden by hair, pointed or rounded, about one fourth as long as tibia or less. 15. Basitibial plate of male well defined at least on posterior margin and apex; no carina extending apicad. 16. Wing vestiture variable; three submarginal cells; basal vein distal to or occasionally meeting cu-v. Stigma slender, not or little broader than prestigma (measured to wing margin), somewhat broader in the subgenus *Porterapis*; marginal cell less than 2.0 to 2.5 times as long as stigma; vein r arising near middle of stigma, margin within marginal cell convex, usually somewhat angulate. Apex of marginal cell narrowly rounded or pointed, separated from wing margin by a few vein widths. 17. Jugal lobe of hind wing not attaining to surpassing level of cu-v. 18. Metasomal sterna with abundant short hair and apical fringes of longer hair. 19. Pygidial plate of male absent or represented by ill-defined elevated area that tapers toward apex of T7 which is rounded, truncate, or emarginate. 20. S7 of male narrow medially, with two pairs of apical lobes, one or both of which is rather narrow or small. 21. S8 of male variable, with base rounded or truncate, rarely pointed; apical process simple and pointed to large and ornate, *not beveled like a pygidial plate*. 22. Male genitalia with or without recognizable gonostylus. Volsella without distinct denticles except in *Lonchoprella*. Penis valves usually large and elaborate, not strongly downcurved.

Distribution: Southern South America, north in the Andean uplift to Colombia.

Comments: This genus contains numerous species. They are diverse in appearance, ranging from rather small forms superficially not easily distinguished from small or middle-sized *Leioproctus* to large and easily recognized forms like *Lonchopria* s. str.

KEY TO THE SUBGENERA OF *LONCHOPRIA*

1. Mandible of male with large tooth or process on lower margin. Clypeus of female without or with weakly differentiated closely punctate upper median area; lateral clypeal area, if differentiated, merely less closely punctate than upper median area 2
—. Mandible of male often with obtuse preapical angle on lower margin but without large tooth or process. Clypeus of female with flat or depressed, relatively closely punctate, upper median area contrasting with impunctate or sparsely punctate, convex, U-shaped lateral and apical region 3
2. Pollex tooth of male mandible enormous, separated from apical part of mandible (rutellum) by curved emargination (Fig. 30e); S8 of male with apical process downcurved, apex expanded and quadrangular; mandible of female unusually slender (Fig. 30g), preapical (pollex) tooth weakly developed. . . . . *Ctenosibyne*
—. Pollex of male mandible not forming the usual preapical tooth; S8 of male with apical process short, pointed, scarcely downcurved; mandible of female more robust with well developed preapical tooth. . . . . *Lonchopria* s. str.
3. Glossa deeply bifid, each lobe longer than prementum; apex of mandible scoop-shaped (Fig. 29i, j), preapical (pollex) tooth reduced in female, absent in male . . . . . *Porterapis*
—. Glossa of the usual bilobed form (sometimes rather deeply so), each lobe less than one third length of

prementum; apex of mandible pointed, usually with strong pollex tooth (which is sometimes double) . . . 4

4. Female with tibial scopal hairs sparse (as in *Leioproctus*), not hiding surface, which is therefore not greatly different from that of basitarsus; body length 7.5-9 mm; jugal lobe of hind wing reaching or surpassing cu-v, over two thirds as long as vannal lobe measured from wing base . . . . . *Lonchoprella*

—. Female with tibial scopal hairs extremely dense, hiding tibial surface, which therefore contrasts strongly with the sparsely haired basitarsus; length variable but most species over 9 mm long; jugal lobe of hind wing usually not reaching cu-v and usually less than two thirds as long as vannal lobe . . . . . *Biglossa*

Lonchoprella new subgenus

Type species: *Lonchopria (Lonchoprella) annectens* new species

This subgenus differs from all other *Lonchopria* by having the tibial scopa similar to that of *Leioproctus*. It thus destroys the most conspicuous difference between the two genera, although other characters support placement of the species in *Lonchopria*. (Figs. 24, 31e)

Description: a. Nonmetallic, metasomal hair bands absent. Length 7.5-9 mm. b. Clypeus of female punctate throughout, lower two fifths and broad convex lateral area sparsely so; of male with distal third impunctate except laterally, the rest punctate, upper part of depressed median area closely punctate. c. Vertex slightly raised behind ocelli, convex; anterior margin of median ocellus almost twice as far from antennal bases as from posterior edge of vertex. d. Mandible of female not expanded ventrad preapically, lower margin uniformly curved. Mandible of male with strong preapical tooth on upper margin; lower margin with rounded preapical angle. e. Labrum of female about twice as broad as long, apex rounded; basal area strongly elevated, occupying two fifths of labrum, with strong transverse carina; of male over twice as wide as long, tapering to narrowly rounded apex, convex basal area shining, weakly binodulose, occupying half of labral length. f. Middle flagellar segments of male about 1.5 times as long as broad. g. Basitibial plate of female bluntly pointed, with hairs, marginal carinae exposed; of male hairless with carinae on both anterior and posterior margins. *Tibial scopa sparse, not hiding surface, with sparse, long branches; hairs of outer surface of hind basitarsus a little longer than those of inner surface so that superficially outer surfaces of hind tibia and basitarsus look similar.* h. Wings with hairs sparse, especially basally. Second submarginal cell longer than third on posterior margin, receiving first recurrent vein near middle. i. *Jugal lobe of hind wing reaching or surpassing cu-v, over two thirds as long as vannal lobe.* j. T7 of male without pygidial plate, with hairless but punctate dorsal area narrowed posteriorly. k. S7 of male with three rather small apicolateral lobes on each side. l. S8 of male with downcurved apical process longer than body of sternum, hairy but not broadened or ornate distally; basal margin truncated. m. Apex of gonoforceps directed apicad, slightly vertically flattened.

Distribution: Argentina (provinces of Santiago del Estero and Catamarca).

Included species: Lonchopria (Lonchoprella) annectens Michener, n. sp.

Comments: Lonchoprella is based on a small species suggestive of *L. (Biglossa) robertsi*, but differs from that species by the scopal and hind basitarsal characters of the female which suggest those of *Leioproctus*. Other characters, including the long second submarginal cell, and the process of S8 of the male, and less diagnostically, the clypeal surface and the preapical expansion of the lower margin of the mandible of the male, are all within the range of variation found among species of *Biglossa*.

The tibial scopal characters appear to be plesiomorphic relative to other *Lonchopria*. Compared to most species of *Lonchopria* the other characters listed under g and i above are also plesiomorphic. I suppose *Lonchoprella* to be the sister group of other *Lonchopria* that retains some of the characters derived from a *Leioproctus*-like ancestor.

Subgenus *Biglossa* Friese

Biglossa Friese, 1906:374. Type species: *Biglossa thoracica* Friese, 1906, by designation of Cockerell, 1914:328.

Biglossidia Moure, 1948:313 (new synonym). Type species: *Biglossa chalybaea* Friese, 1906, by original designation.

Aeganopria Moure, 1949:442 (new synonym). Type species: *Lonchopria nivosa* Vachal, 1909, by original designation.

Leioproctus (Biglossa, Biglossidia, and *Aeganopria*); Michener, 1965:41.

This is the largest subgenus of *Lonchopria*. There is a flat or depressed, closely punctate upper median clypeal area at least in females, surrounded laterally and below by large, convex, shining and often impunctate areas. This feature is shared with certain other subgenera, but the ordinary bilobed glossa, distinct tooth of the mandibular pollex (= upper preapical mandibular tooth), dense tibial scopal hairs, and

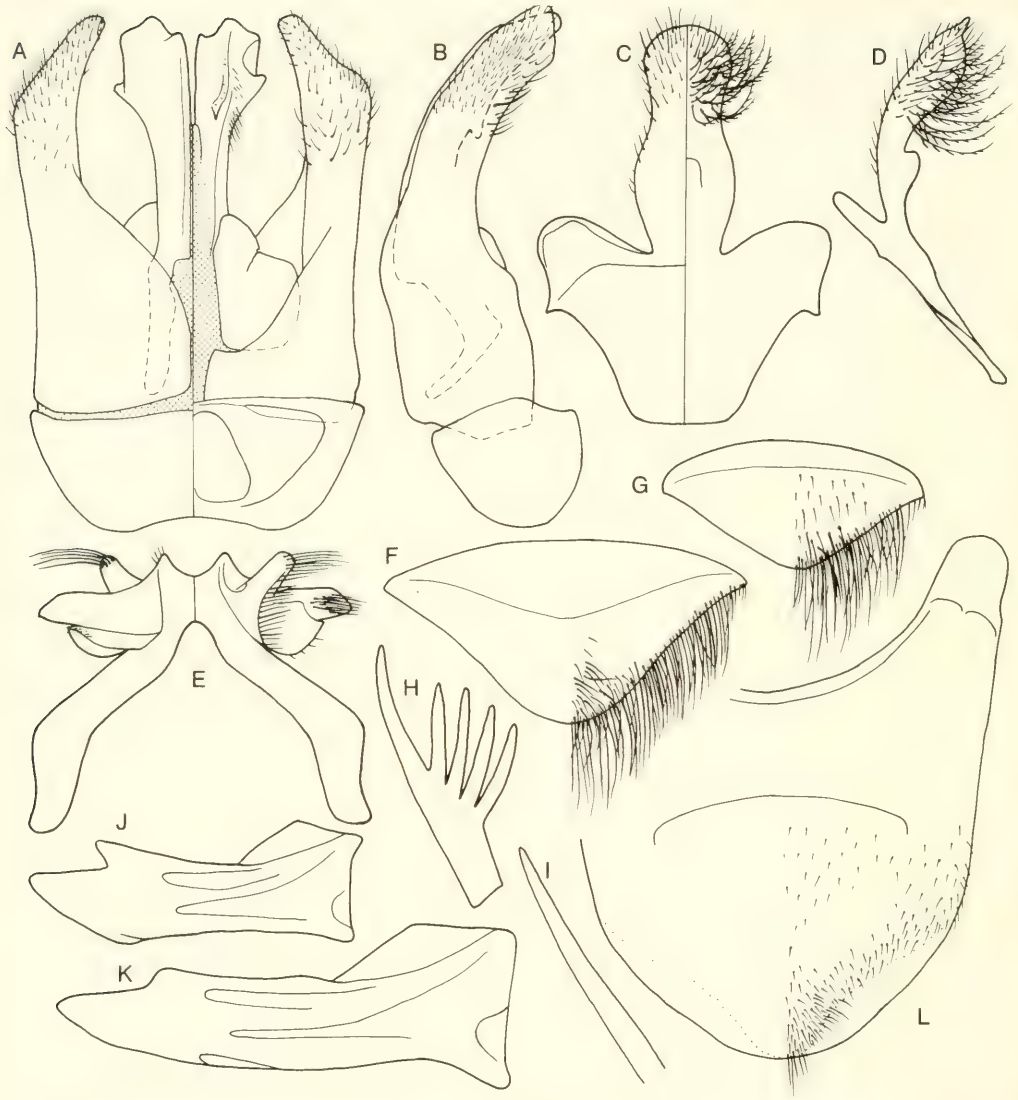

FIG. 24. *Lonchopria (Lonchoprella) annectens* n. sp. **a-e.** Genitalia, S8 and S7 of male. **f, g.** Labrum of female and male. **h, i.** Inner and outer hind tibial spurs of female. **j, k.** Mandibles of male and female. **l.** S6 of male (sides curved strongly away; sternum would be much broader if flattened).

strong, downcurved, hairy and often ornate process of T8 of the male distinguish *Biglossa*. (Figs. 25, 26, 27, 28, 31f, g)

Description: a. Metasoma slightly blue or green metallic to black, with or without pale hair bands, sometimes (*L. robertsi*, female) uniformly covered with pale hair or (*L. nivosa*, female) with broad mid-dorsal areas of pale hair. Length 8-14 mm. b. Clypeus with broad, convex, usually hairless, impunctate and shining sublateral areas, usually connected across lower clypeal region and thus forming a U surrounding flat or depressed, central, more densely punctate area; shining convexities occasionally with a few punctures or in *L. chalybaea, inca, longicornis*, and *nivosa* with numerous punctures and hairs (dense in male). (In *L. inca* male, depressed central area scarcely recognizable.) c. Vertex little developed behind ocelli (swollen behind ocelli in *L. inca* and extending posteriorly in *L. nivosa*); anterior margin of median ocellus much farther from antennal bases than from posterior edge of vertex except in *L. nivosa, L. thoracica* female, and one unidentified female from Argentina, perhaps of this subgenus; in these forms the anterior margin of the median ocellus is about equidistant between antennal

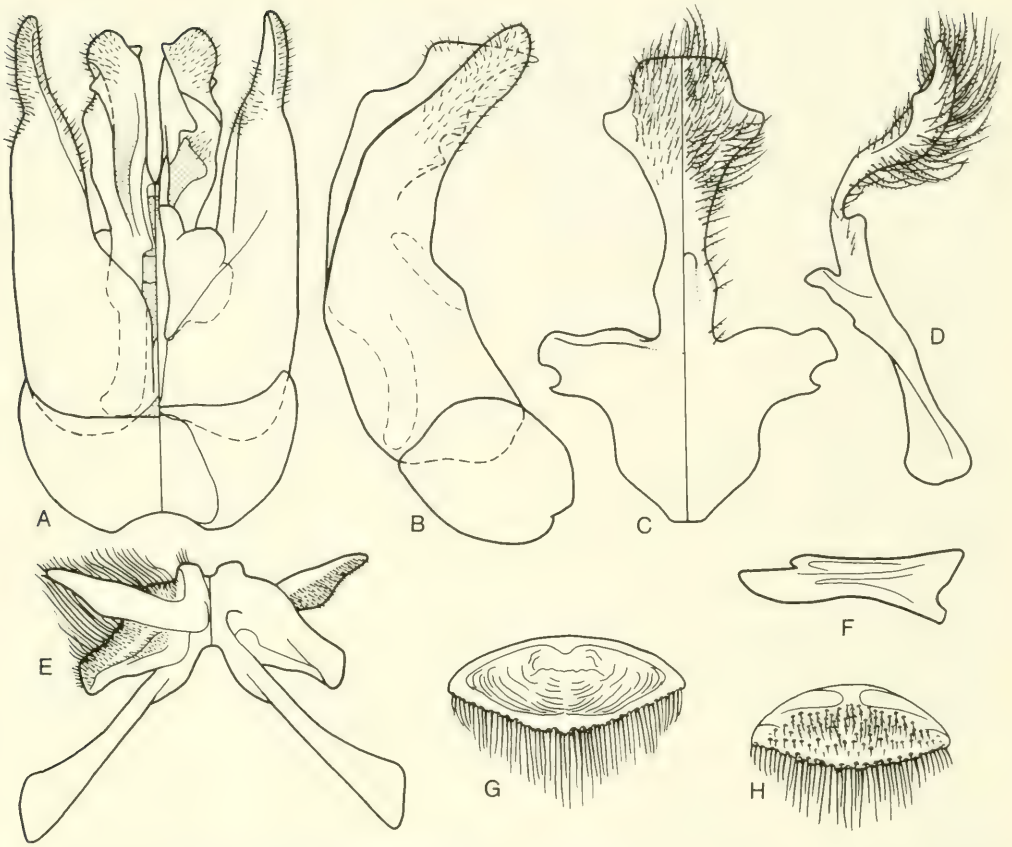

FIG. 25. *Lonchopria (Biglossa) chalybaea* (Friese). **a-e.** Genitalia, S7 and S6 of male. **f.** Mandible of male. **g, h.** Labrum of female and male.

bases and posterior edge of vertex. d. Mandible of female not expanded ventrad preapically, lower mandibular margin therefore uniformly curved, except in *L. robertsi* which is expanded (Fig. 28f). Mandible of male with preapical tooth (two such teeth in *L. thoracica* and an approach to two in *L. longicornis*) on upper margin (apex of pollex) strong, separated by narrow notch from rutellum or sometimes (as in *L. robertsi*) oblique with no notch; in *L. nivosa* with broad emargination instead of narrow notch; lower margin preapically usually expanded ventrad forming preapical convexity (not in *L. nivosa, thoracica*, and some others). e. Labrum of female more than twice as wide as long (less in *L. robertsi*; in *L. thoracica* length about 0.75 width), apex straight or rounded, sometimes emarginate, convex basal area strongly elevated, sometimes binodulose, occupying half to most of length of labrum, in latter case apical depressed zone only narrow margin; of male about twice as wide as long (or as wide as long in *L. thoracica*), tapering to narrowly rounded or emarginate apex, convex basal area shining or roughened, sometimes binodulose, sometimes (e.g., *L. chalybaea*) merely a strong ridge across base of labrum but usually occupying more than half of labral length. f. Middle flagellar segments of male 1.5 to more than 2.0 times as long as broad. g. Basitibial plate of female rounded at apex, with hairs, strong marginal carina sometimes exposed; of male represented by apex and posterior carina only, increasing in height toward apex, anterior margin not or scarcely recognizable, or in some species (e.g., *L. nivosa, robertsi*) anterior carina present. h. Wings hairy throughout or basally largely hairless (*L. robertsi*). Second submarginal cell usually longer than third on posterior margin, receiving first recurrent vein near middle; shorter than or equal to third in *L. thoracica, nivosa*, and various others. i. Jugal lobe half to three fifths as long as vannal lobe, usually not reaching level of cu-v. (In *L. robertsi* nearly two thirds as long as vannal lobe and reaching level of cu-v; in *L. nivosa* four fifths as long as vannal lobe and exceeding level of cu-v.) j. T7 of male without pygidial plate, sometimes with longitudinal median bare zone, sometimes with large but undefined bare area; apex of T7 rounded (in

L. robertsi with two small, sharp apical horns). k. S7 of male with paired apicolateral hairy lobes, one pair broad, the other rather slender, or both rather slender. l. S8 of male with usually downcurved apical process, shorter to longer than body of sternum, broadened and hairy distally, without or usually with small to large lateral or lateroapical projection from enlarged apex; basal margin rounded or obtusely angulate without noticeable projecting spiculum; margin lateral to base of apical process rounded, shoulder-like. m. Apex of gonoforceps directed apicad, vertically flattened, rather membranous beneath and simple in shape except with ventral angular projection basal to membranous ventral surface in *L. thoracica*.

Distribution: Western Argentina (Mendoza to Jujuy) and north in the Andean uplift through Bolivia and Peru to Colombia. Some species occur in xeric lowlands while others occur at least as high as 3874 m in the Peruvian Andes.

Included species: Lonchopria (Biglossa) aenea (Friese, 1906); *alopex* Cockerell, 1917; *chalybaea* (Friese, 1906) = *armata* (Friese, 1906); *deceptrix* (Moure, 1949), new combination [*Biglossidia*]; *inca* Cockerell, 1914; *longicornis* Michener, n. sp.; *nivosa* (Vachal, 1909); *robertsi* Michener, n. sp.; and *thoracica* (Friese, 1906). There are also numerous undescribed species.

Comments: Most of the species could be placed in a subgenus *Biglossidia* Moure but if this were done, then *Biglossa* s. str. would stand as a monotypic subgenus for *L. thoracica*, derived from *Biglossidia* and differing from it in a few striking apomorphies, as follows: Mandible of male with two preapical teeth, thus tridentate; male mandibular rutellum long, almost parallel-sided; labrum more elongate than usual, about as long as wide in male, 0.75 as long as wide in female, apex emarginate in both sexes; claws of female almost simple, inner ramus represented by minute tooth. The male mandibular character is not as distinctive as it seems. A specimen from Mendoza shows the tridentate condition clearly (Fig. 26f).

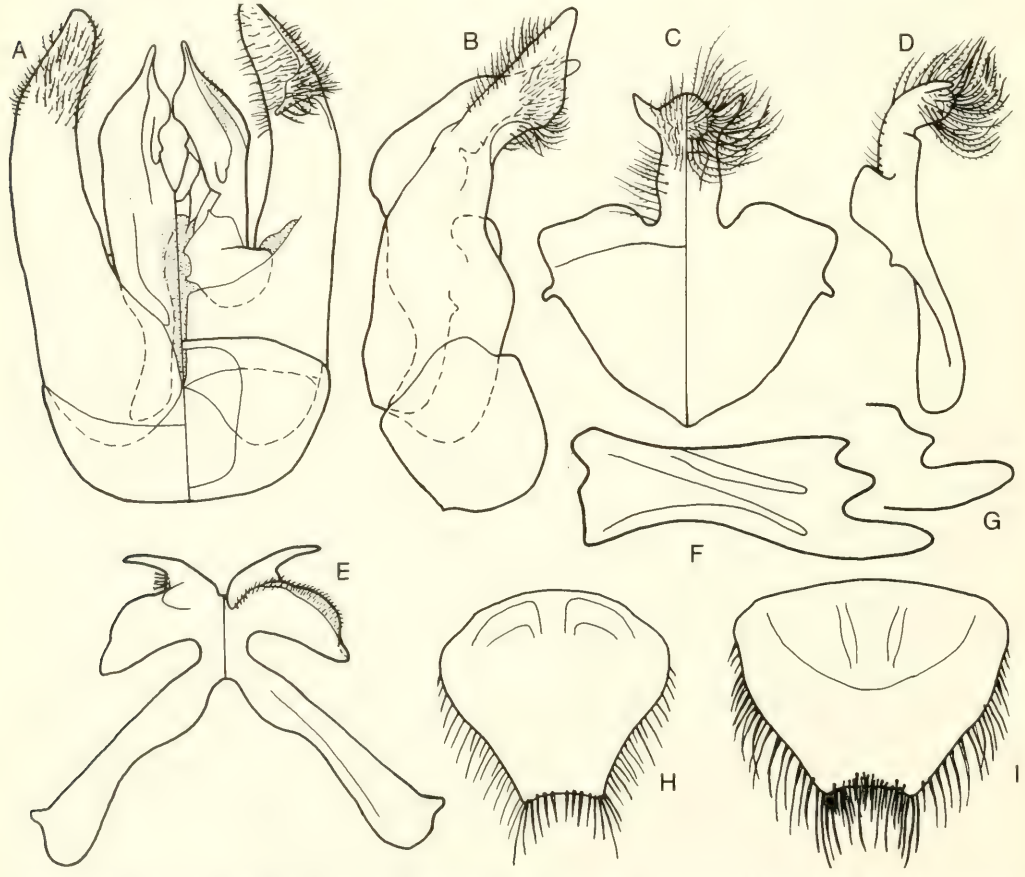

FIG. 26. *Lonchopria (Biglossa) thoracica* (Friese). **a-e.** Genitalia, S8 and S7 of male. **f, g.** Mandible of male from Mendoza and apex from Tucumán. **h, i.** Labrum of male and female.

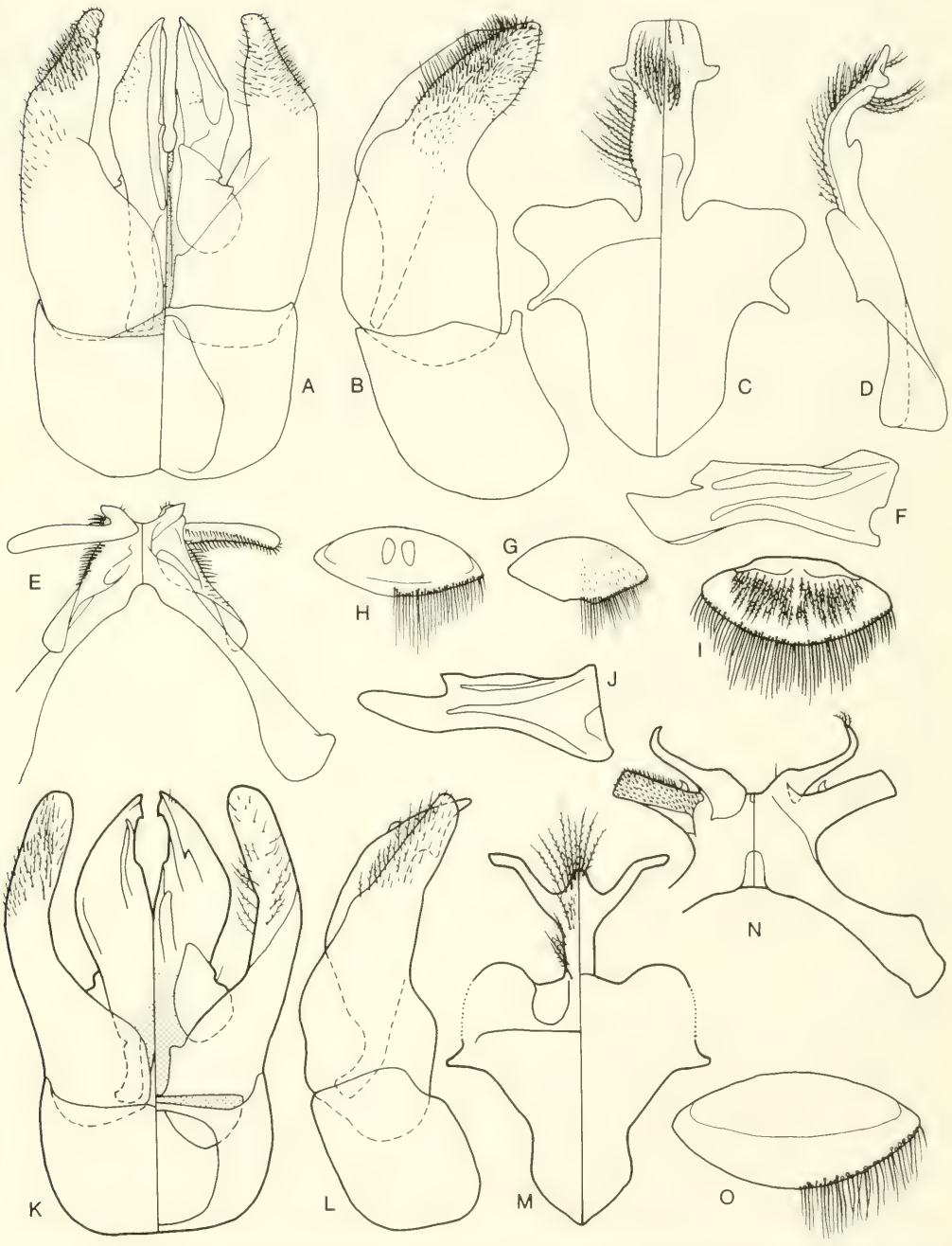

FIG. 27. **a-h.** *Lonchopria (Biglossa) longicornis* n. sp. **a-e.** Genitalia, S8 and S7 of male. **f.** Mandible of male. **g, h.** Labrum of male and female. **i-o.** *L. (B.) nivosus* (Vachal). **i.** Labrum of male. **j.** Mandible of male. **k-n.** Genitalia, S8 and S7 of male. **o.** Labrum of female.

Three specimens from Tucumán Province are similar to the Mendoza individual and have similar terminalia but have the two preapical mandibular teeth less well developed (Fig. 26g). The male of *L. longicornis* has a nearly straight margin (Fig. 27f) where the two teeth are in *L. thoracica*. Thus intergradations exist between the bidentate and tridentate condition. The terminalia of *L. thoracica* fall well within the range of variation among species placed in *Biglossidia*. It does not seem that *L. thoracica* is different enough from other species to justify putting it in a separate subgenus and thus making *Biglossidia* one more paraphyletic unit.

Another distinctive species, *L. nivosa* Vachal, has received the generic name *Aeganopria* Moure. Its most diagnostic features are: clypeal margin of female with four strong, equidistant teeth hidden among hairs; mandible of male with strong preapical tooth (apex of pollex) widely separated from long, almost parallel-sided rutellum; jugal lobe longer than in other species, about four-fifths as long as vannal lobe and exceeding level of cu-v; T7 of male broadly subtruncate at apex and bearing strong apical fringe, hairs longest sublaterally; S8 of male (Fig. 27m) not downcurved, sparsely hairy, with long apicolateral process on each side; ventral projection on apical process of S8 absent. The long jugal lobe and the straight and sparsely haired S8 may be plesiomorphic relative to other groups of *Biglossa*. In this case *Aeganopria* would be the sister group to the other *Biglossa* species and could well be recognized as a subgenus. The other characters of *Aeganopria*, however, are probable apomorphies relative to other groups of *Lonchopria* and the polarization of the wing and S8 characters is uncertain. *L. nivosa* falls within the general range of variability for *Biglossa* and a subgeneric name for it does not seem justified, although it is easily recognized by the generally dark pubescence, coarse punctation of the head, thorax, and T1, and in the female, broad dorsal areas of pale pubescence on T3, T4, and the apex of T2, the pale-haired areas not reaching the sides of the terga.

The species included in *Biglossidia* by Moure (*chalybaea, aenea,* and *deceptrix*, for a key to species see Moure, 1949) all have metallic blue reflections from the metasomal terga. The male of *B. chalybaea,* the type species of *Biglossidia*, differs from the other described and undescribed species in (1) the broadly punctate clypeus, densely covered with nearly erect hair except for a protruding, shining boss at each end of the clypeal truncation; (2) the strongly elevated, protruding clypeal margin proper below the above mentioned boss; (3) the short elevated basal area of the labrum, merely a shining binodulose ridge across the base of the labrum; (4) the rather dense, short, pale hair occupying a labral zone beyond the elevated basal ridge; (5) the zone of hair over half as long as the flagellar diameter along the under side of the flagellum from base to apex; and (6) the large, right-angular, preapical tooth on the under side of the hind tibia; and (7) the swollen hind femur (illustrated by Moure, 1949, pl. xi). The female of the same species is unusual in having punctures on the elevated and shining parts of the clypeus. Thus *L. chalybaea* is about as distinctive as are *L. nivosa* and *thoracica*. In *L. chalybaea* and some others including *L. deceptrix*, S6 of the male is produced medially as a hairy, rounded process. In *L. aenea*, however, S6 is broadly rounded apically.

No character other than the blue metasoma appears to differentiate *Biglossidia* in Moure's original sense from diverse other species such as *L. longicornis*. Identifications by Moure of undescribed species in the collection of J. L. Neff show that Moure also included nonmetallic species also in *Biglossidia*. The blue species are rather large and robust (length 9-13 mm) while the nonmetallic species include similarly large forms like *L. inca*, intermediate sized forms like *L. longicornis*, and smaller forms like *L. robertsi*. Some, particularly *L. inca*, have apical pale hair bands so that they resemble superficially the subgenera *Lonchopria* s. str. and *Porterapis*. Others have basal pale hair bands as well (weakly developed in female *L. longicornis,* better developed in an unnamed species whose male is not yet recognized). In females of L. robertsi the terga are uniformly covered with pale appressed hair.

In most species the glossal lobes are about as long as broad or slightly more, but in a few such as *L. robertsi* they are over twice as long as broad.

Porterapis new subgenus

Type species: *Lonchopria porteri* Ruiz, 1936.

In size, body form, and pale hair bands on the metasomal terga, this subgenus resembles *Lonchopria* s. str. Morphologically, however, it resembles *Biglossa* from which it differs in the long glossal lobes (suggestive of *Leioproctus* subgenera *Glossopasiphae* and *Tetraglossula*) and scoop-shaped mandibles. (Fig. 29)

Description: a. Nonmetallic with narrow apical bands of pale hair on metasomal terga. b. *Clypeus flat,* not protuberant; lateral areas shining, nearly impunctate, connected by broad, similarly smooth zone across lower end of clypeus (in male lower half of clypeus, in female somewhat less); upper central densely punctate region not depressed in male, only slightly so in female. c. Vertex somewhat developed behind ocelli but

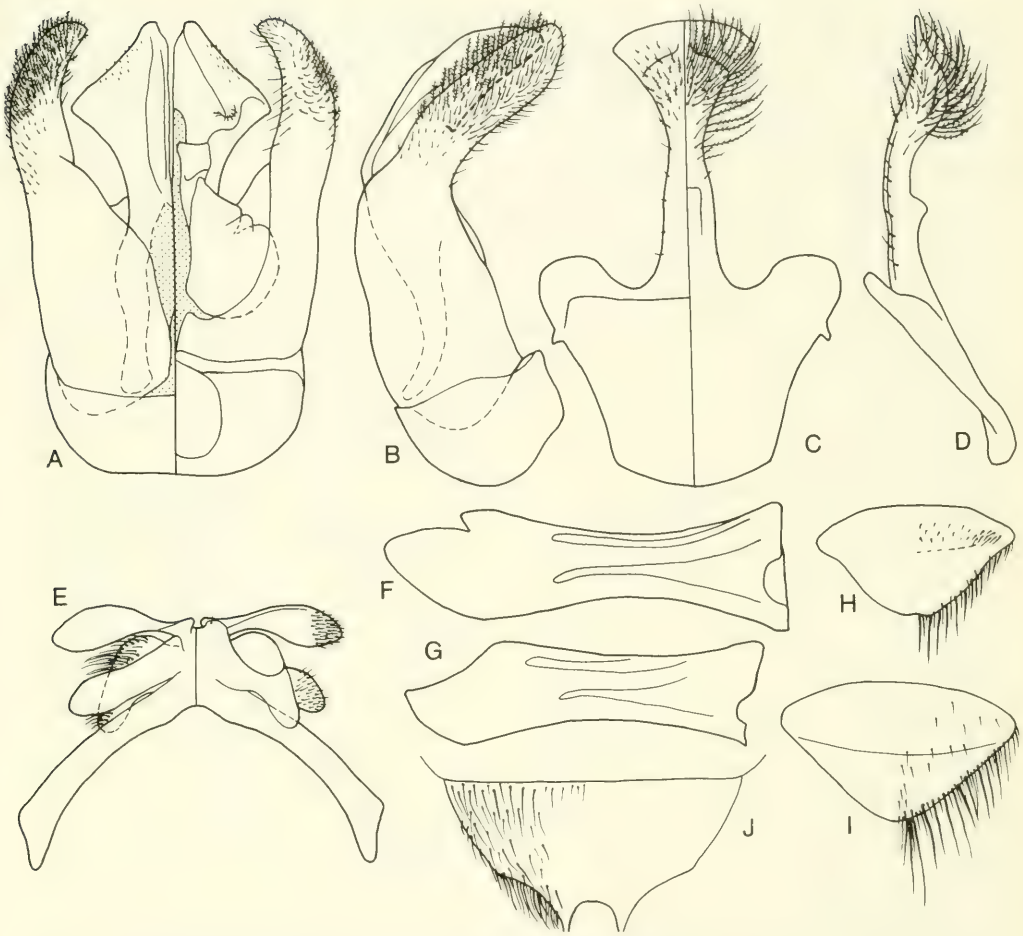

FIG. 28. *Lonchopria (Biglossa) robertsi* n. sp. **a-e.** Genitalia, S8 and S7 of male. **f, g.** Mandibles of female and male. **h, i.** Labrum of male and female. **j.** T7 of male.

anterior margin of median ocellus nearer to posterior margin of vertex than to antennal bases. d. Mandible especially of male expanded ventrad preapically; *apex broad and scoop-shaped, preapical tooth of upper margin* (Fig. 29i, j) *reduced in female, absent in male. Glossal lobe* (sense of Michener and Brooks, 1984) *produced as slender hairy appendage longer than prementum and directed distad;* thus glossa deeply bifid (Fig. 29h). e. Labrum less than twice as broad as long, apex truncate in female, emarginate in male; *narrow strip across base scarcely elevated.* f. Middle flagellar segments of male nearly twice as long as broad. g. Basitibial plate of female narrowly rounded at apex, completely covered with hair, posterior marginal carina visible from some positions; of male pointed, carina on anterior side present only near apex. *Claws of female strongly curved, inner ramus reduced to small subbasal tooth.* h. Wings with basal parts except near costal margin of forewing hairless or nearly so. Second submarginal cell longer than third on posterior margin, receiving first recurrent vein at middle. i. Jugal lobe about three fifths as long as vannal lobe, nearly attaining level of cu-v. j. T7 of male with vaguely indicated bare pygidial area at apex; *apex of T7 obtusely pointed.* S6 of male produced apically as a hairy, rounded projection suggesting that of *L. (Biglossa) chalybaea.* k. S7 of male with *three pairs* of apicolateral hairy lobes, all rather slender. l. S8 of male with downcurved apical process longer than body of sternum, abruptly broadened and hairy at apex; basal margin broadly truncate; margin lateral to base of apical process very strongly convex, posteriorly produced.

Distribution: Central Chile (Coquimbo region).

Included species: Lonchopria (Porterapis) porteri Ruiz, 1936.

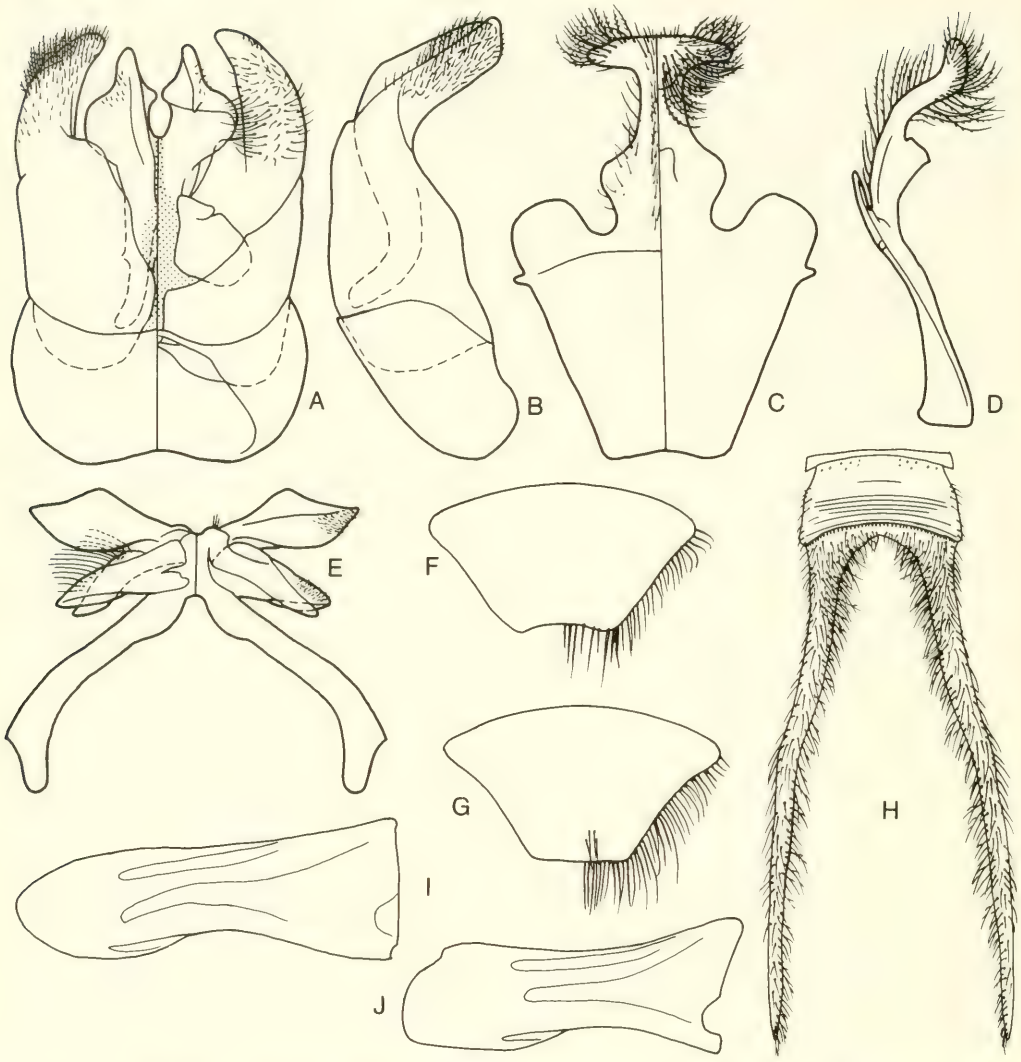

FIG. 29. *Lonchopria (Porterapis) porteri* Ruiz. **a-e.** Genitalia, S8 and S7 of male. **f, g.** Labrum of male and female. **h.** Glossa (male). **i, j.** Mandibles of male and female.

Comments: This subgenus is perhaps a derivative of *Biglossa*, which would therefore be paraphyletic. It is so distinctive, however, that it seems worth recognizing, especially since *Biglossa* has an apomorphy (the preapical angle on the lower mandibular margin of males, absent in some probably derived species) suggesting that it and *Porterapis* are sister groups.

Etymology: The subgeneric name was first used at the genus level by Padre J. S. Moure at least a third of a century ago, but was not published. It is a partial patronymic for Carlos Porter, Chilean naturalist, in recognition of his work on Chilean insects, plus *apis*, Latin for bee.

Subgenus *Lonchopria* Vachal s. str.

Lonchopria Vachal, 1905:204. Type species: *Lonchopria herbsti* Vachal, 1905 (= *Colletes zonalis* Reed, 1892 (monobasic).

Leioproctus (Lonchopria); Michener, 1965:41; Toro, 1973a:146.

This subgenus includes rather large, robust species, with abundant pale hair usually forming apical bands on the metasomal terga. The most distinctive features are the lack of the preapical (pollex) tooth on the upper margin of the male mandible and the rather short, tapering apical process of T8 of the male. (Figs. 30h, 31h; Figs. 83-109, Toro, 1973a)

Description: a. Nonmetallic, metasomal hair bands present or absent; basal bands absent. Length 8.5 (for small males) to 15 mm. b. *Clypeus of female punctate throughout, upper median area usually not appreciably depressed, lateral and distal areas with punctures and hairs only somewhat sparser than in central area;* male with distal part broadly shining, impunctate, hairless or nearly so, not strongly convex. c. Vertex little developed behind ocelli, anterior margin of median ocellus farther from antennal bases than from posterior margin of vertex (lateral view). d. Mandible of female with cap of rutellum usually expanded ventrad so that lower margin of mandible is not a uniform curve. *Mandible of male without the usual preapical pollex tooth but with large tooth along lower margin* (see figures in Toro, 1973a). e. *Labrum (both sexes) over two to four times as wide as long,* apex straight (transverse) or rounded; *convex basal area* impunctate, *occupying most of surface so that depressed apical part is only narrow margin* (figures in Toro, 1973a). f. Middle flagellar segments of male about 1.5 times as long as wide. g. Basitibial plate pointed, in female well defined, with hairs but not hidden; in male usually incomplete on anterior margin. h. Wings hairy throughout. Second submarginal cell shorter than third, receiving first recurrent vein near base to near middle. i. Jugal lobe about three fifths as long as vannal lobe, not reaching level of cu-v. j. T7 of male with elevated bare pygidial region (not distinctly margined), narrowed toward apex; apex of T7 truncate or slightly emarginate. k. S7 of male with paired apicolateral lobes small, slender (as in *L. similis*) or lower one rounded (*L. zonalis*), sparsely hairy to hairless (figures of this and characters l and m in Toro, 1973a). l. *S8 of male with apical process tapering, acutely pointed, not appreciably downcurved*, hairy; basal margin convex without pointed spiculum; margin lateral to base of apical process concave, farther laterally shoulderlike. m. Gonobase unusually short (Toro, 1973a); apex of gonoforceps relatively slender, directed mesad, perhaps representing gonostylus differentiated from gonocoxite (Toro, 1973a; lateral view Fig. 30h).

Distribution: Central Chile. One specimen [AMNH] from Catamarca Province, Argentina.

Included species: Lonchopria (Lonchopria) similis (Friese, 1906) [*Biglossa*]; *rufithorax* Ruiz, 1944; and *zonalis* (Reed, 1892) [*Colletes*]. The first and last are common. Another possibly included species is *L. luteipes* (Friese, 1916), the type of which has not been found; see Toro (1973a). This Chilean subgenus has been reviewed, and the species excellently illustrated, by Toro (1973a).

Comments: Lonchopria s. str. is quite different from other subgenera, and might have been regarded as a genus separate from *Biglossa* and *Porterapis* except for the intermediacy of *Ctenosibyne*. That subgenus has sparsely punctate areas on each side of the median depressed area of the clypeus in females, suggestive of the usually impunctate areas of *Biglossa* and *Porterapis*. The male mandible has a tooth or process on the lower margin in both *Lonchopria* s. str. and *Ctenosibyne*. The volsellae appear acutely pointed apically as seen from above or beneath in both subgenera, because the apices are compressed. Unique derived features of *Lonchopria* s. str. include the short, pointed apical process of S8 of the male which is not appreciably downcurved; the rather small, paired apical lobes of S7 (Toro, 1973a); the short gonobase; and the large penis valve with two downward directed prongs (Fig. 30h). *Ctenosibyne* is intermediate between *Biglossa* and *Lonchopria* s. str. in gonobase, gonoforceps, and penis valve characters but more like *Biglossa* in S8.

Subgenus *Ctenosibyne* Moure

Lonchopria (Ctenosibyne) Moure, 1956, Dusenia 6:311. Type species: *Lonchopria (Ctenosibyne) cingulata* Moure, 1956 (original designation and monobasic).
Leioproctus (Ctenosibyne); Michener, 1965:41.

This subgenus contains a large robust species similar to those of *Lonchopria* s. str. The tooth on the lower margin of the male mandible is a unique synapomorphy uniting *Lonchopria* s. str. and *Ctenosibyne*. The characters italicized below are the principal distinctive features of the subgenus. (Figs. 30a-g, 31d; Figs. 4-6, Moure, 1956)

Description: Similar to *Lonchopria* s. str. except as follows: a. T2-4 with broad basal pale hair bands as well as apical ones. b. Female with clypeus punctate throughout, upper median part distinctly depressed and more closely punctate than shiny and sparsely punctate areas lateral to it; *male with clypeus uniformly punctate and hairy, slightly depressed medially*. d. *Mandible of female unusually slender*, cap of rutellum not at all expanded, lower margin of mandible a uniform curve; *preapical dorsal tooth (of pollex) scarcely developed* (Fig. 30g). Mandible of male with preapical dorsal tooth (of pollex) enormous, separated from rutellum by broad concavity; cap of rutellum expanded ventrad; lower margin with large triangular tooth before middle (Fig. 30e). e. Labrum (both sexes) with length about half of width, tapering to narrow truncate or feebly emarginate apex; convex basal area of female elevated to strong transverse ridge medially, dull, median length equal to that of depressed apical area; in male convex basal area shining, with a few short hairs apically, length much less than that of depressed apical area. g. Basitibial plate of female long but rounded apically; of male with anterior margin carinate like posterior margin. j. T7 of male with broad bare area but not elevated as a pygidial area; apex of T7 rounded. k. S7 of male with paired apicolateral lobes rather slender but hairy (Fig. 4, Moure, 1956). l. *S8 of male with apical*

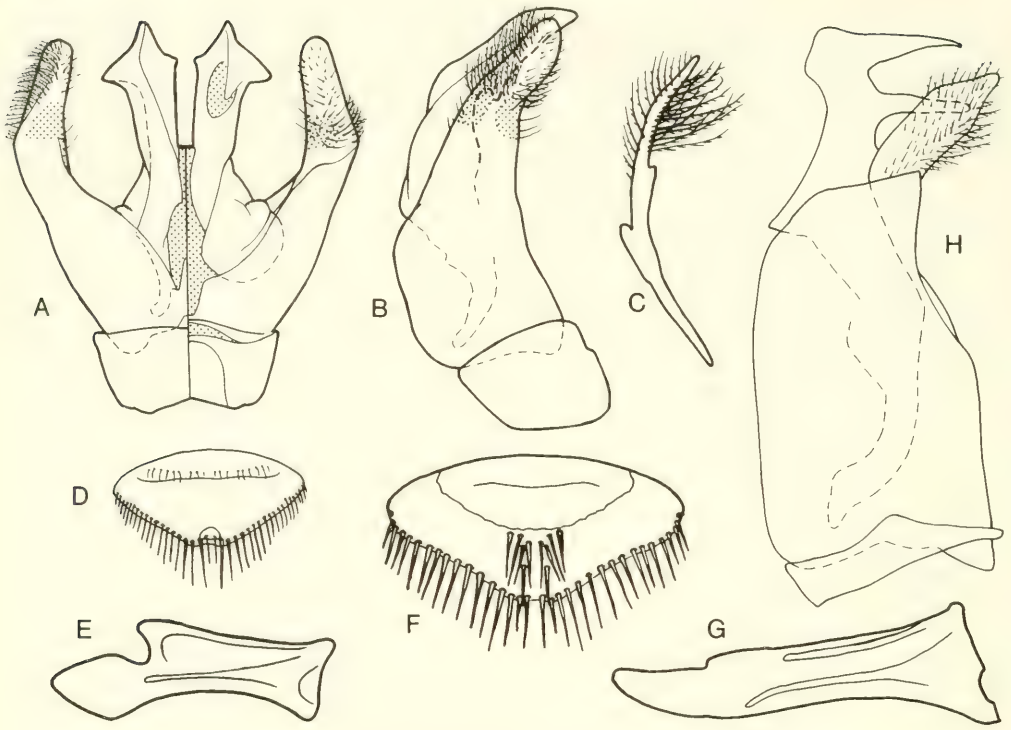

FIG. 30. **a-g.** *Lonchopria (Ctenosibyne) cingulata* Moure. **a, b.** Genitalia of male. **c.** S8, side view, male. **d, e.** Labrum and mandible of male. **f, g.** Labrum and mandible of female. **h.** *L. (Lonchopria) similis* (Friese), genitalia of male, side view.

process large, downcurved, apically abruptly broadened and truncate; basal margin rounded without projecting spiculum; margin lateral to base of apical process arcuate posteriorly, shoulderlike (Fig. 5, Moure, 1956). m. Gonoforceps without separate distal (possibly gonostylus) region (Fig. 6, Moure, 1956, and Fig. 30a, b); penis valves less modified than in *Lonchopria* s. str.

Distribution: Southern Brazilian plateau (Paraná).

Included species: Lonchopria (Ctenosibyne) cingulata Moure, 1956.

Figure 30a is a new drawing of the genitalia; Moure's (1956) illustration seems to have been based on an abnormal individual (a paratype [Lawrence]). Moure's figure of S7 has the dorsal view on the right, not the left as in the other figures.

TRIBE COLLETINI

The tribal characteristics listed in the key above are all apomorphic relative to the Paracolletini and other similar bees such as *Andrena*. The relationships of this tribe to the Paracolletini are considered in the discussion of that tribe. There are two genera, separable as follows:

KEY TO THE GENERA OF COLLETINI

1. T1 with anterior surface not broadly concave, often with a longitudinal median concavity; dorsal surface of T1 about as long as exposed part of T2 and at least two thirds as long as anterior surface of T1 seen in profile; second recurrent vein usually sigmoid with posterior half arcuate distad (Fig. 1b), rarely angulate distad at alar fenestra on flexion line; base of propodeum with short subhorizontal to vertical basal

zone usually defined posteriorly by a carina or sharp change in slope or sculpture and divided by longitudinal carinae which may delimit strong pits . . . . . *Colletes*

—. T1 with anterior surface broadly concave; dorsal surface of T1 much shorter than exposed part of T2 and less than two thirds as long as anterior surface of T1 seen in profile; second recurrent vein with posterior half straight or gently arcuate, anterior part not curved in the reverse direction, thus vein not sigmoid (Fig. 31i); base of propodeum with sloping basal zone nearly smooth, not traversed by longitudinal carinae . . . . . *Mourecotelles*

Genus *Mourecotelles* Toro and Cabezas

This genus, found only in temperate South America, appears to be the sister group to *Colletes*. Its apomorphies relative to *Colletes* include the shape of T1 (perhaps two independent characters) and the short, almost globose metasoma with T6 of the female scarcely excerted. The apomorphies of *Colletes* include all the characters listed in the key to genera except those of T1. The appropriate outgroup is the Paracolletini, and *Mourecotelles* has more characters like those of Paracolletini than does *Colletes*. (Fig. 31i; Figs. 1-40, 94-96, Toro and Cabezas, 1977; Figs. 41-97, Toro and Cabezas, 1978).

I here unite three genera described by Toro and Cabezas (1977, 1978) under a single generic name since they are similar to one another and I think the relationships relative to *Colletes* are better indicated in that way. Of the two names available for this genus, *Hemicotelles* and *Mourecotelles*, I use the latter because it is the larger and much commoner group (8 included species compared to 2 in *Hemicotelles*), even though the former has page priority.

There are three subgenera of *Mourecotelles*. *Hemicotelles* and *Xanthocotelles* have simple claws in the female, an apomorphic character relative to Colletinae in general. The same two subgenera have what Toro and Cabezas regard as a rudimentary pygidial plate, absent in *Mourecotelles* s. str. I have not seen the female of *Hemicotelles* but in *Xanthocotelles* there is only a small, bare, elevated area at the apex of T6. It may well be an apomorphic feature rather than a remnant of a pygidial plate, for it is narrowed to a point anteriorly, instead of broadened anteriorly like a pygidial plate. Even *Mourecotelles* s. str. has the same region broadly elevated, quite unlike *Colletes*, although not clearly defined or bare as in *Xanthocotelles*. Thus it seems likely that *Mourecotelles* s. str. is the sister group to the other two subgenera taken together. Apomorphies of *Mourecotelles* s. str. include the convex apical half of the lower margin of the male mandible (see Toro and Cabezas, 1977).

KEY TO THE SUBGENERA OF *MOURECOTELLES*

1. Basal zone of propodeum margined posteriorly by weak carina; middle flagellar segments of male about twice as long as wide. (Claws of female simple.) . . . . . *Hemicotelles*

—. Basal zone of propodeum not margined posteriorly by carina; middle flagellar segments of male less than twice as long as wide 2

2. Claws of female simple; tibiae and tarsi reddish yellow . . . . . *Xanthocotelles*

—. Claws of female cleft; tibiae and tarsi largely blackish . . . . . *Mourecotelles* s. str.

Subgenus *Mourecotelles* Toro and Cabezas s. str.

Mourecotelles Toro and Cabezas, 1977:50. Type species: *Mourecotelles mixta* Toro and Cabezas, 1977, by original designation.

This subgenus, the only one with cleft claws in the female and also the only one with the pygidial plate completely absent, was revised and illustrated by Toro and Cabezas (1977). The eight described species are found in Chile, Argentina, and Bolivia.

Subgenus *Hemicotelles* Toro and Cabezas

Hemicotelles Toro and Cabezas, 1977:46. Type species: *Lonchopria ruizii* Herbst, 1923, by original designation.

This subgenus was revised and illustrated by Toro and Cabezas (1977). The two species range from central Chile to Santa Cruz Province in Argentina. The type species was erroneously included in *Lonchopria* by Michener (1965).

Subgenus *Xanthocotelles* Toro and Cabezas

Xanthocotelles Toro and Cabezas, 1978:131. Type species: *Xanthocotelles adesmiae* Toro and Cabezas, 1978, by original designation.

This subgenus was revised and illustrated by Toro and Cabezas (1978). The eleven known species are found in central Chile south to Aisén

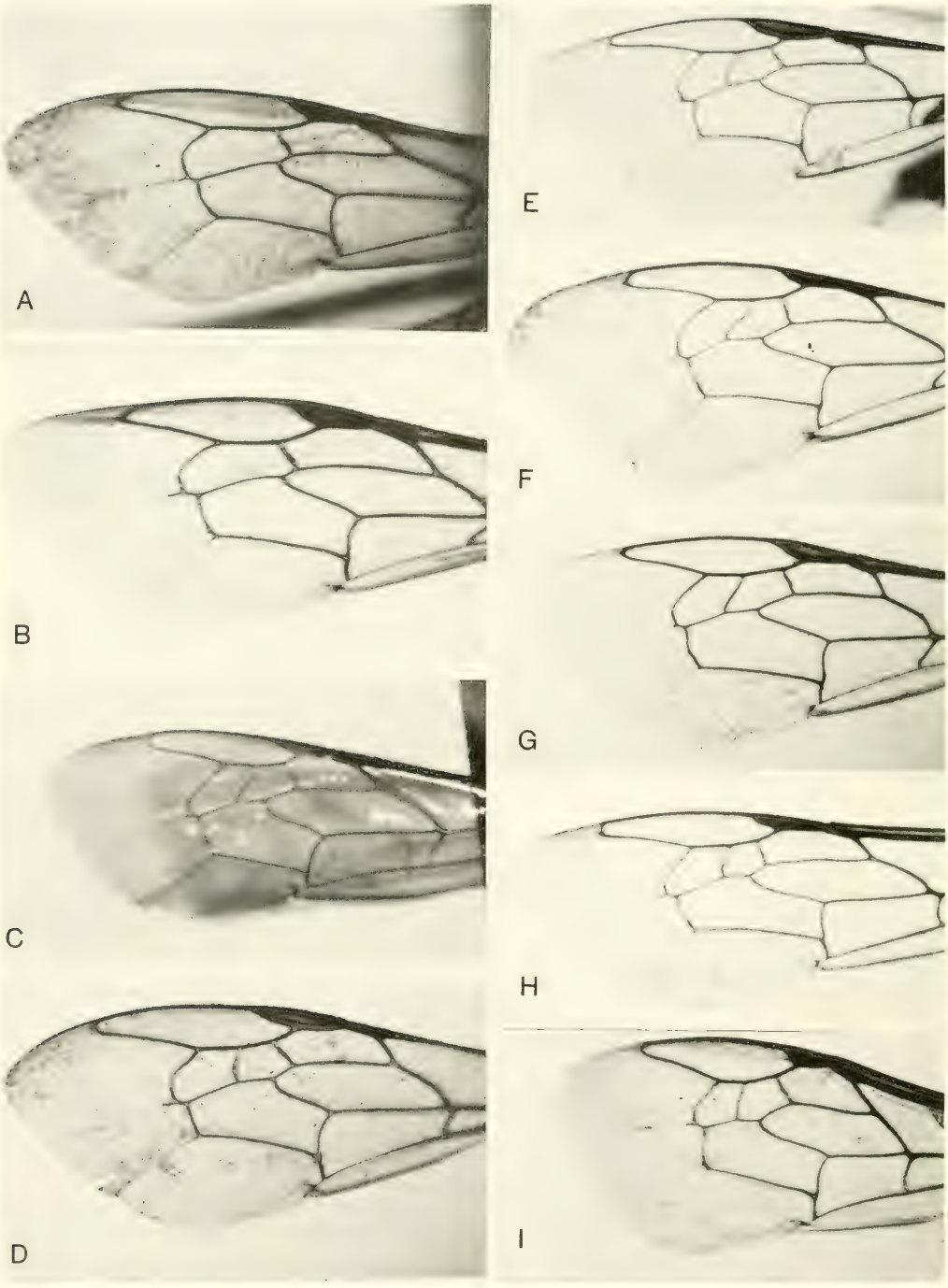

FIG. 31. Forewings. **a.** *Brachyglossula rufocaerulea* (Friese). **b.** *Niltonia virgilii* Moure. **c.** *Lonchorhyncha ecuadoria* (Friese). **d.** *Lonchopria (Ctenosibyne) cingulata* Moure. **e.** *Lonchopria (Lonchoprella) annectens* n. sp. **f.** *Lonchopria (Biglossa) thoracica* (Friese). **g.** *L. (B.) robertsi* n. sp. **h.** *L. (Lonchopria) zonalis* (Reed). **i.** *Mourecotelles (Mourecotelles) mixta* Toro and Cabezas.

Province and xeric parts of Argentina (provinces of Catamarca and Mendoza).

Genus *Colletes* Latreille

Colletes Latreille, 1802:423. Type species: *Apis succincta* Linnaeus, 1758 (monobasic).

Evodia Panzer, 1806:207. Type species: *Apis calendarum* Panzer, 1802 = *Apis succincta* Linnaeus, 1758 (monobasic).

Monia Westwood, 1875:221 (not Gray, 1850), new synonym. Type species: *Monia grisea* Westwood, 1875 (monobasic).

Monidia Cockerell, 1905b:9, new synonym. Type species: *Monia grisea* Westwood, 1875 (autobasic). New name for *Monia* Westwood.

Rhinocolletes Cockerell, 1910:242. Type species: *Colletes nasutus* Smith, 1853.

Ptilopoda Friese, 1921:83. Type species: *Colletes (Ptilopoda) maculipennis* Friese, 1921 = *Colletes spiloptera* Cockerell, 1917 (monobasic).

Denticolletes Noskiewicz, 1936:486. Type species: *Colletes graeffei* Alfken, 1900 (monobasic).

Puncticolletes Noskiewicz, 1936:490. Type species: none designated. Therefore name not valid under International Rules of Zoological Nomenclature article 13b. Warncke (1978) considers *Puncticolletes* a synonym of *Rhinocolletes*.

Rhynchocolletes Moure, 1943:447, new synonym. Type species: *Rhynchocolletes albicinctus* Moure, 1943, by original designation.

Pachycolletes Stoeckhert, 1954:73. Type species: *Apis cunicularia* Linnaeus, 1761, by original designation. (Stoeckhert cites Bischoff as responsible for this name, as does Warncke, 1978. However, the description appears to be the work of Stoeckhert.)

Albocolletes Warncke, 1978:353. Type species: *Halictus albomaculatus* Lucas, 1849, by original designation.

Elecolletes Warncke, 1978:330. Type species: *Colletes elegans* Noskiewicz, 1936, by original designation.

Nanocolletes Warncke, 1978:341. Type species: *Colletes nanus* Friese, 1898, by original designation.

Simcolletes Warncke, 1978:348. Type species: *Colletes similis* Schenck, 1853, by original designation.

This genus is found in all continents except Australia. The long synonymy above results from two tendencies: The first is the giving of names to each unusual species. Thus *Monidia* contains a Mexican species with the last antennal segment of the male expanded and with long hairs on the hind tibiae of the male. *Denticolletes* contains a Palearctic species with the axilla produced and angulate. *Rhinocolletes* (Palearctic) and *Rhynchocolletes* (Brazilian) each contains a species with the malar area unusually long and with the clypeus produced, the latter having the legs of the male modified. *Ptilopoda* contains two species (Texas to Panamá) with spotted wings and somewhat modified hind legs in the male. The second tendency is to give names to groups of the less exceptional species in limited geographical areas, in this case the western Palearctic. These names should simply be ignored until the genus is reviewed worldwide and appropriate subgroups recognized. (Fig. 1b; figures in Stephen, 1954; Noskiewicz, 1936; etc.)

Rhynchocolletes is also unusual in the short mandibles of the male (shorter than malar area), the broad, deep concavity between the ocelli and the summit of the eye, and the second recurrent vein which is only gently arcuate outward in the posterior portion and straight in the anterior portion, thus not S-shaped. It is known only in the male. The short mandible and the form of the second recurrent vein are suggestive of *Mourecotelles* but neither character is decisive because intergradation occurs among more ordinary species.

The *Colletes* species of America north of Mexico were revised by Stephen (1954); those of Latin America have never been reviewed. Particularly in temperate South America the fauna is diverse and beautiful; some species have metallic blue metasomas, some have bright red thoracic hair, and various species have long malar areas suggesting *Rhinocolletes* and attaining the extreme in *Rhynchocolletes*.

EXCLUDED TAXA

Stenocolletes Schrottky

Stenocolletes Schrottky, 1909:253; 1913:238. Type species: *Stenocolletes pictus* Schrottky (monobasic).

This generic name was included in the Colletidae by Schrottky and by subsequent authors, including Michener (1965). However, the reason for that placement is obscure, for Schrottky says that the tongue of his two specimens was hidden. *S. pictus* was based upon two male bees 7 mm long with three submarginal cells and with the following parts dull yellow: longitudinal streak on mandible, inner orbits, posterior margin of pronotum, tegula, spots on the second, third, and sometimes fourth metasomal segments, tarsi, anterior tibia (almost wholly), and bases of other tibiae. No American colletid known to me has such integumental markings. The specimens appear to be lost but most probably were panurgine bees of the genus *Psaenythia* or possibly *Liphanthus*. Schrottky (1913) regarded it as the most distinctive of the hairy Colletidae, a fact suggesting that it was not a colletid.

Orphana Vachal

This genus was originally included in the Col-

letidae and on the basis of literature was placed as a subgenus of *Leioproctus* by Michener (1965). It is, however, an andrenid of the subfamily Andreninae, as shown by Rozen (1971) and Michener (1986c).

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These remarks would be incomplete without reference to the important works on South American Colletinae by Padre J. S. Moure, published from 1943 to 1964 and by Prof. Haroldo Toro, published from 1970 to 1977. Both authors published illustrations that moderated the number that had to be included in the present work. Padre Moure recognized (usually at the genus level) many of the taxa here described. His identifications left in various collections and his preliminary catalogue have proved invaluable to me.

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APPENDIX

The Appendix contains descriptions of the new species mentioned in the earlier parts of this paper, together with certain taxonomic adjustments at the species level.

Collections housing specimens are cited by city names in square brackets. The following is a list of the institutions concerned:

1. Austin - J. L. Neff collection, Central Texas Melittological Institute, Austin, Texas, U.S.A.
2. Berlin - Zoologisches Museum an der Humboldt-Universität, Berlin, D.D.R.
3. Buenos Aires - Museo Argentina de Ciencias Naturales "Bernardino Rivadavia," Buenos Aires, Argentina.
4. Curitiba - Faculdade de Filosofia, Universidade Federal do Paraná, Curitiba, Paraná, Brazil.
5. La Plata - Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata, La Plata, Argentina.
6. Lawrence - Snow Entomological Museum, University of Kansas, Lawrence, Kansas, U.S.A.
7. Logan - U.S.D.A. Bee Biology and Systematics Laboratory, Utah State University, Logan, Utah, U.S.A.
8. New Brunswick - Department of Entomology and Economic Zoology, Rutgers University, New Brunswick, New Jersey, U.S.A.
9. New York - American Museum of Natural History, New York, New York, U.S.A.
10. Washington - National Museum of Natural History, Washington, D.C., U.S.A.

Leioproctus (Perditomorpha) arnauellus new name

Perditomorpha arnaui Moure, 1954:168 [homonym of *Nomiocolletes arnaui* Moure (1949:441) in *Leioproctus*].

I pointed out the above homonymy long ago (Michener, 1965). It seems appropriate now to rename the junior homonym.

Leioproctus (Perditomorpha) eulonchopriodes new species

This species resembles *L. (P.) iheringi* in the extraordinarily coarse punctation, but differs in having yellow apical integumental bands on some of the metasomal terga. Not only do the presence of these bands and the coarse punctation suggest *Eulonchopria*, but also the elevated rims at the extreme margins of the terga and the darkened costal margin of the forewing are *Eulonchopria*-like, and different from other *Perditomorpha*. (Fig. 2a-f)

Description: Nonmetallic black except for yellowish integumental tergal bands and reddish coloration on legs. Metasomal terga completely without hair bands.

Male: Length about 7 mm; forewing length 6.5 mm. *Structure*. Eyes distinctly converging below except for upper extremities which converge above. Ocelloccipital distance about 1.8 ocellar diameters; interocellar distance over two ocellar diameters, > ocellocular distance; distance from anterior edge of median ocellus to posterior edge of vertex much less than that to antennal bases. Vertex behind ocelli raised, convex. Clypeus not protuberant; clypeoantennal distance about twice diameter of antennal socket; malar area linear. Labrum nearly five times as long as wide, apex broadly and gently concave, basal two fifths convex, smooth and shining, distal three fifths depressed, with scattered short hairs basal to fringe. Antennal scape not reaching anterior ocellus; flagellum short, wider than scape, segment 1 scarcely longer than broad, 2 and 3 about twice as wide as long, remaining segments wider than long except last which is about 1.3 times as long as wide. Propodeum in profile with base sloping and somewhat shorter than metanotum; triangular area unusually small, at base about one third as wide as propodeum, marginal line pitted but not conspicuously so because pits no larger than nearby punctures. Wings hairy throughout, basal vein of forewing scarcely distal to cu-v, second submarginal cell scarcely shorter than posterior margin of first, receiving first recurrent vein about one fifth of length of cell from base; jugal lobe of hind wing exceeding level of cu-v, about two thirds as long as vannal lobe measured from base. Basitibial plate with apex rounded, surface shining, with a few short hairs. Pygidial area only slightly paler and less densely hairy than adjacent areas. Hidden sterna and genitalia as in Fig. 5a-d and f. *Surface*. Punctation extremely coarse and rather dense, interspaces much less than a puncture width, smooth, shining; clypeus with transverse preapical impunctate line with upper margin irregular; supraclypeal area punctate, slightly more finely so than clypeus; genal area much more finely punctate than most of body; small area lateral to ocelli, lower part of hypoepimeral area, and propodeal triangle smooth, shining; most coarsely punctured areas are mesepisternum and discs of T1-3; posterior marginal zones of T1-3, and to a lesser extent succeeding terga, broadly depressed and more finely punctate than discs of terga, narrower posterior margins impunctate and on T1-3 strongly upturned; sterna rather sparsely and finely punctate, surface minutely roughened. *Color*. Black; distal half of mandible, tegula, trochanters and femora dark reddish brown; flagellar segments 3-11, tibiae and tarsi yellow-brown; T1, 3, and 4 with broad, apical, yellow bands occupying entire depressed marginal zones; T5 and 6 with similarly broad zones, brownish in the specimen, possibly yellowish in well preserved material; T1-6 with margins translucent; S1-5 with margins inconspicuously

brownish translucent. Wings grayish, costal margin from stigma to apex distinctly darkened. *Pubescence*. Mostly extremely short and sparse, light brown or on venter, whitish; longer, denser, pale brown, and plumose on face (largely obscuring surface across middle of face and on paraocular area, especially near antennal base), genal area, posterior margin of vertex, posterior lobe of pronotum and vicinity, venter of mesepisternum (white), side of scutellum, metanotum, and side of propodeum (especially above); legs also with somewhat longer hair. Sternal hair bands weak and inconspicuous except for long, dense, apical fringe on S5.

Holotype male: Argentina: Salta Prov., Pocitos, November, 1956 (M. Fritz) [Lawrence].

Comments: As in species of *Nomiocolletes*, ordinary relaxing of the specimen in a humid atmosphere for dissection of genitalia and mouthparts results in a change in the integumental bands from strongly colored to brownish translucent. They are no longer strongly colored in the holotype.

Etymology: The specific name is the stem of the generic name *Eulonchopria* plus *odes*, indicating resemblance.

Leioproctus (Perditomorpha) inconspicuus new species

This is a representative of the group of *L. arnauellus* and *brunerii (Perditomorpha* s. str.) as indicated by the leg and sternal scopae of the female and T7 of the male, but differs from those species and resembles most other *Perditomorpha* species in having a coarsely pectinate inner hind tibial spur of the female. It is markedly smaller than other species of *Perditomorpha* s. str. Its characters are summarized in the Comments under the subgenus *Perditomorpha*. (Fig. 3a-f)

Description: Nonmetallic black; pubescence largely pale, almost not forming tergal hair bands.

Male: Length 5.5-7 mm, forewing length 4.5-5 mm. *Structure*. Inner orbits converging below. Ocelloccipital distance over 1.5 ocellar diameters; interocellar and ocellocular distances equal to about three ocellar diameters. Vertex behind ocelli convex, weakly elevated. Clypeus not protuberant; clypeoantennal distance more than diameter of antennal socket; malar area absent; genal area narrower than eye seen from side. Antenna almost reaching tegula; scape not quite reaching median ocellus; flagellar segments 2 and 3 about twice as wide as long, segments 1, 9, and 10 about as wide as long, middle segments broader than long, segment 11 about 1.75 times as long as wide. Second submarginal cell nearly as long as first, receiving first recurrent vein near base. Basitibial plate narrowly rounded at apex, surface with scattered short hairs arising from conspicuous bases. Hidden sterna and genitalia as in Fig. 3a-e. *Surface*. Head, thorax, and T1 (except posterior margin) smooth and shining except for punctures. Face below antennae punctate throughout, punctures separated by less than half a puncture width; above antennae punctures sparser, area between and behind ocelli impunctate, ocellocular area with punctures widely separated; genal area with many small punctures. Thoracic punctures similar in style to those of clypeus, mostly separated by about a puncture width, discal areas of scutum and scutellum with punctures smaller and separated by nearly two diameters, hypoepimeral area with punctation similar to adjacent areas or with only limited smooth regions. Propodeal triangle smooth, marginal lines deeply impressed but not or weakly pitted. Metasomal terga much more finely punctate than thorax, T1 with punctures separated by several puncture widths, T2-7 more closely punctate, T1-6 with depressed posterior marginal zones which are impunctate apically but with minute punctures near bases, surfaces of these zones minutely roughened, like rest of surfaces of T2-6. Sterna minutely roughened and with widely separated small punctures, except close on S6. *Color*. Black, following parts dark reddish brown: apical two thirds of mandible, under side of flagellum, tarsi, anterior surface of front tibia, sometimes other tibiae, depressed, translucent marginal zones of T1-6 and weakly on S1-4 or 5. Tegula dusky brown. Wings infuscated brownish, veins and stigma blackish brown. *Pubescence*. Dusky yellowish white, not forming metasomal bands although a little denser near apices of terga than elsewhere, especially laterally, very sparse on sterna except for apical fringe on S4, dense apical fringe on S5, and dense short hairs apically on S6.

Female: Length 5.5-7 mm, forewing length 4.5-5 mm. Agrees with description of male except as follows: *Structure*: Interocellar and ocellocular distances less than three ocellar diameters. Scape often reaching anterior ocellus; flagellum shorter than in male, segments 2-3 more than twice as wide as long, 4-5 about twice as wide as long, 9 sometimes as wide as long, 10 about 1.5 times as long as wide. Inner hind tibial spur with six to eight long teeth. *Surface*: Punctation finer and sparser than in male, only clypeus nearly as strongly punctate as in male; supraclypeal area with lower central area with only scattered punctures, otherwise punctures mostly separated by several puncture widths except closer on lower part of frons, front and sides of scutum, sides and posterior part of scutellum. Punctures on T1-4 minute and widely separated. S2-5 with broad apical bands of coarse punctures or hair bases. *Color*. Tibiae and tarsi brownish black; basal parts of S2-5 brown. Base of pygidial plate red. *Pubescence*. Generally more yellowish than in male. Dorsal pubescence of thorax short, strongly plumose, ochraceous; some hairs dusky in some lights along outer surface of hind tibia beyond basitibial plate; scopal hairs of S2-4 yellowish.

Type material: Holotype male, allotype female, and six male and nine female paratypes: Argentina: Salta Prov., Tartagal, 502 m altitude, 16

Mar. 1984 (R. B. Roberts) [Lawrence; paratypes in New Brunswick, Curitiba, Buenos Aires]. Thirty male and one female paratypes: Salta Prov., Campo Durán, 51 km north-northeast of Tartagal, 500 m altitude, 16 March 1984 (R. B. Roberts) [Lawrence, New Brunswick, Curitiba, Buenos Aires].

Other material: Bolivia: Depto. Santa Cruz: 2 and 12 km west of Montero, 300 m altitude, 19 and 21 Feb. 1976; Santa Cruz de la Sierra, botanical garden, 400 m altitude, 17 Feb. 1976; 34 km south of Santa Cruz de la Sierra, 500 m altitude, 24 Feb. 1976; 15 km southwest of same, 400 m, 10 Mar. 1976; San Javier, 600 m altitude, 2 Mar. 1976 (all collected by R. B. Roberts) [New Brunswick, Lawrence].

Comments: Additional characters of this species are given in the Description and Comments under the subgenus *Perditomorpha*.

Etymology: The specific name is the Latin for inconspicuous, with reference to the small size, dull coloration, and "ordinary" appearance of this species, which is nonetheless important in showing the intergradation of *Perditomorpha* and the formerly recognized *Bicolletes*.

Leioproctus (Kylopasiphae) pruinosus new species

In appearance, including the pale appressed hair covering T2-4 of the female and more erect pale hair on the metasoma of the male, this species resembles *Lonchopria robertsi* and *Leioproctus (Pygopasiphae) mourellus*, species that occur in the same area. It differs, of course, in the striking generic and subgeneric characters. It is the only known species of its subgenus. (Figs 5a-f, 10f, 23e)

Description. Nonmetallic black; pubescence white.

Male: Length 7-8 mm, forewing length 5-5.5 mm. *Structure*. Inner orbits converging below. Ocelloccipital distance about 1.5 ocellar diameters; interocellar distance about three ocellar diameters, greater than ocellocular distance. Vertex behind ocelli gently convex, not elevated. Clypeus scarcely protuberant, flat in profile; clypeoantennal distance more than diameter of antennal socket; malar area short, about one third as long as diameter of pedicel; genal area as wide as eye seen from side. Antenna reaching base of scutellum, scape not reaching anterior ocellus, first and second flagellar segments subequal in length, wider than long, third segment about 1.5 times as long as wide, remaining segments slightly over 1.5 times as long as wide. Second submarginal cell as long as first, receiving first recurrent vein one fourth of cell length from base. Basitibial plate with only four or five short hairs. Hidden sterna and genitalia as in Fig. 5a-e. *Surface*. Smooth and shining except for punctures. Clypeus smooth and shining except for areas of small, rather dense punctures at extreme sides and across upper margin; somewhat less dense punctures extending down in longitudinal median zone from upper margin to below middle of clypeus; supraclypeal area with large triangular impunctate area extending to point at level of lower margins of antennal sockets; rest of lower half of face with fine, rather dense punctures, except sparse near eye margin; frons with strong punctures separated by about two diameters; ocellocular area impunctate, extending down near eye margin as sparsely punctate zone; gena and vertex behind ocelli with moderate sized dense punctures. Thorax coarsely punctate including side and posterior surface of propodeum; scutum with punctures mostly separated by two or more diameters, anterior median part and posterior part of disc nearly impunctate, anterolateral part closely punctate; scutellum similar but anterior part of disc impunctate; mesepisternum and side of propodeum with punctures mostly separated by less than a puncture width; lower part of hypoepimeral area and propodeal triangle impunctate. Metasomal terga with punctures about as large as those of vertex behind ocelli, separated by several puncture widths, posterior margins of T1-6 broadly impunctate. T7 with surface shiny, coarsely and irregularly roughened. Metasomal sterna with surfaces microreticulate, diffuse bands of fine punctures across posterior parts of S1-5, such punctures occupying much of exposed surface of S6. *Color*. Black, apical two fifths of mandible and pygidial part of T7 red; flagellum brownish black; tarsi and apex of front tibia yellow brown; tegula translucent pallid posteriorly; apical margins of T1-6 broadly translucent pale brown; sterna dark brown. Wings transparent, veins and stigma brown. *Pubescence*. White, long, erect, especially long and dense on genal and hypostomal areas; hairs arising near upper margin of clypeus directed apicad over impunctate region and ending below apex of clypeus; metasomal terga with short, appressed, white hair in addition to long and more or less erect hair; appressed hair forming basal bands that nearly hide surface on T3-5; T6 covered with such hair; S2-5 with apical fringes of long yellowish hair, similar on all four sterna.

Female: Length 8-8.5 mm; forewing length 5.2-5.5 mm. Agrees with description of male except as follows: *Structure*. Flagellum shorter, segments 1 and 4-9 about as long as wide, 2 much wider than long, 3 slightly so, 10 nearly twice as long as wide. Basitibial plate—see subgenus. *Surface*. Clypeus with no band of punctures across upper margin and only small area laterally; upper central part with scattered rather coarse punctures down to below middle of clypeus; lower half of face with punctate areas having coarser punctures than in male, resembling punctation of frons; ocellocular area with numerous minute punctures. T2-4 with punctures much finer than those behind ocelli. *Color*. Basitarsi sometimes dusky. T1-5 with apical margins broadly translucent yellow-brown. *Pubescence*. A little more yel-

lowish than in male dorsally, prepygidial and pygidial fimbriae usually yellowish; sternal scopal hairs yellowish. Hairs of head shorter than in male, not at all covering clypeus from above; T2-4 with erect hairs rather short, appressed hairs uniformly dispersed and not forming basal (or apical) hair bands; pygidial and prepygidial fimbriae long and dense; sternal scopal hairs forming band across apex of each sternum.

Type material: Holotype male, allotype female, and 19 male and 7 female paratypes: Argentina: Tucumán Prov., 5 km east of Amaicha, 26 Nov., 1983 (R. B. Roberts) [Lawrence; paratypes in New Brunswick, Curitiba, Buenos Aires].

Other material: Additional specimens of the same or closely related species are from Andalgalá, Catamarca Prov. (IBP desert scrub site), on *Larrea divaricata* (one male on *L. cuneifolia*), 22 Oct. 1972, and 10 and 19 Oct. 1973; one from same locality, on *Bulnesia retama* (no pollen on scopa), 5 Oct. 1973 (all J. L. Neff). Capillitas Desert, Catamarca Prov., on *Larrea divaricata*, 23 Dec. 1973 (J. L. Neff). Quebrada La Aguadita, La Rioja Prov., 20 km north of La Famacina, on *Larrea divaricata*, 13 Nov. 1969 (A. Willink-Stange-A. Terán collectors). Villa del Agrio, Néuquen Prov., on *Larrea divaricata* (J. L. Neff) (male flagellum largely brown) [all Austin].

Etymology: The specific name is the Latin *pruinosus*, covered with frost, with reference to the uniformly distributed white hairs on the metasoma of the female.

Leioproctus (Leioproctus) fulvoniger new species

This is the only known species of its subgenus in the Americas. It differs from all other American species in the characters indicated in the account of subgenera. (Figs. 5g-l, 19c)

Description: Nonmetallic black and largely dark haired, without tergal hair bands; pubescence of dorsum of thorax fulvous.

Male: Length 9 mm; forewing length 7.5 mm. *Structure*. Eyes converging below except for upper extremities which converge above. Ocelloccipital distance about 1.2 ocellar diameters; interocellar distance nearly two ocellar diameters, slightly less than ocellocular distance; distance from anterior edge of median ocellus to posterior edge of vertex less than that to antennal bases. Vertex not raised behind ocelli, gently convex seen from front. Clypeus not protuberant; clypeoantennal distance slightly more than diameter of antennal socket; malar area linear. Antennal scape not quite reaching anterior ocellus; flagellar segment 1 about as long as broad, 2 nearly twice as broad as long, 3 slightly broader than long, remaining segments longer than broad. Pygidial plate not defined, represented on T7 by shining area, impunctate and hairless distally and with well separated punctures basally. Hidden sterna and genitalia as in Fig. 5h-l. *Surface*. Head and thorax strongly punctured, interspaces between punctures smooth, shining. Clypeus, supraclypeal area, and lower paraocular areas coarsely punctate, closely so in longitudinal central, feebly depressed part of clypeus, less closely so in narrow preapical transverse zone of clypeus (broken by punctures medially) and broad lower lateral areas; rest of head less coarsely punctate with shining, nearly impunctate areas immediately behind ocelli, between ocelli and eye, and in location of facial fovea (which is otherwise not indicated). Dorsum of thorax and sides of propodeum with punctation nearly as coarse as that of frons, mesepisternum more coarsely punctate but lower hypoepimeral area and area on mesepisternum below it impunctate; metapleuron mostly impunctate. T1 and posterior zones on T2-6 shining and impunctate; rest of terga shining with only minute and widely separated punctures. Sterna largely impunctate except for broad, preapical, strongly punctured zones on S2-5 and large apical area on S6. *Color*. Black, apical half of mandible dark red; flagellar segments 2-11 dark brown except for blackish upper surface; tegula translucent light brown; small segments of tarsi, metasomal sterna, and apical bands of terga rufescent; tibial spurs red-brown. Wings, including stigma and veins, dark brown. *Pubescence*. Sparse, rather short, and brown on head; longer, denser, dark brown (or on parts of mesepisternum blackish) on sides of thorax and on propodeum; dark brown to black on legs except red-brown on under sides of tarsi; bright fulvous on dorsum of thorax and posterior lobe of pronotum; metasomal hairs short (longer on sterna), more or less erect, blackish with reddish reflections in some lights.

Female: Length 11 mm; forewing length 8 mm. Differs from description of male as follows: *Structure*. Eyes only slightly converging below. Ocelloccipital distance scarcely more than ocellar diameter. Antennal scape reaching beyond lower edge of anterior ocellus; flagellar segment 1 slightly longer than broad, 2 over twice as broad as long, 3 about twice as broad as long, 4-7 slightly broader than long, 8 and 9 about as broad as long, 10 twice as long as broad. Pygidial plate strongly rounded (not subtruncate) apically, margins strongly diverging anteriorly. *Surface*. Narrow preapical zone of clypeus impunctate and not broken medially. Center of mesoscutum with punctures in some areas separated by several puncture widths; impunctate area on mesepisternum below hypoepimeral area inconspicuous. T1 and broad posterior zones on T2-5 shining and impunctate; rest of terga rather dull but with only minute and widely separated punctures, better developed on posterior terga. Sterna largely dull and minutely roughened but S2-6 with broad preapical strongly punctured zones and narrow apical impunctate shining margins. *Color*. Black; mandible, under side of apical half of flagellum, legs, metasomal sterna, and apical margins of terga dark reddish; tegula, last flagellar segment, femora, and bases of fore and mid tibiae red

brown. *Pubescence*. Fuscous hairs intermixed with brown on head, some lower clypeal hairs longer, coppery blackish; hairs on side of propodeum lighter brown, on upper part fulvous; hairs of T5 slightly longer than those of sterna; hairs of metasoma and much of legs plainly black.

Type material: Holotype male: Brazil: Santa Catarina, Corupá, Nov., 1953 (A. Maller) [Lawrence]. Allotype female: Santa Catarina, Nova Teutonia, 27°11'S, 52°23'W, 300-500 m altitude (F. Plaumann) [Lawrence].

Comments: The species name was given in manuscript (i.e., on a label) over thirty years ago by Padre J. S. Moure, associated with a new generic name. Additional specimens are presumably in Moure's collection in Curitiba, Brazil, but have not been available for study.

Etymology: Based on the Latin *fulvus*, tawny, plus *niger*, black, with reference to the striking tawny and black hair coloration.

Leioproctus (Glossopasiphae) plaumanni new species

This species has exactly the form and coloration of *Andrena carlini* Cockerell, a common bee of eastern North America. It is superficially similar to another unusual species of *Leioproctus, L. (Leioproctus) fulvoniger*, from the same locality as the specimens of *L. plaumanni*. It is the only species of *Glossopasiphae* and its most distinctive features are indicated in the subgeneric description. (Figs. 6, 19d)

Description: Nonmetallic black with much black pubescence.

Male: Length 12 mm, forewing length 9 mm. *Structure*. Eyes diverging below. Ocelloccipital distance about four ocellar diameters; interocellar distance over two ocellar diameters and about two thirds of ocellocular distance. Clypeus protuberant (in side view, over half eye width); clypeoantennal distance about equal to diameter of antennal socket; malar area almost linear. Antennal scape almost reaching anterior ocellus; flagellum short and rather slender, about as wide as distal part of scape, segment 1 longer than wide, segment 2 wider than long, succeeding segments progressively longer so that 9 and 10 are noticeably longer than wide; segment 11 over 1.5 times as long as wide. Second submarginal cell (2+3) only slightly shorter than first, receiving first recurrent vein about one fourth of length of cell from base. Basitibial plate with short, appressed hairs not obscuring surface. Hidden sterna and genitalia as in Fig. 6a-e. *Surface*. Head and thorax finely and rather densely punctate, punctures mostly separated by half a puncture width or less, ground between punctures finely roughened; clypeus not more coarsely punctate than rest of face, with irregular longitudinal median smoother line; vertex more finely and less closely punctate than face with impunctate area lateral to ocelli. Propodeal triangle with numerous transverse striae especially laterally, surface roughened and rather dull. T1-5 and S1-5 with surfaces minutely roughened and with small, widely separated punctures, densest (especially on sterna) just basal to depressed marginal punctureless zones which are widest on terga. *Color*. Black; tegula translucent brown; distal half of mandible dark reddish; tibial spurs light brown; under side of flagellum, tibiae, tarsi (lighter apically), and depressed marginal zones of terga and sterna brownish black; wings grayish brown, veins and stigma brown. *Pubescence*. On head dusky, yellowish on labrum and mandible, black on face. On thorax pale yellowish, dusky laterally and ventrally. On legs and metasoma dusky, forming strong fringes on S2-5.

Female: Length 14 mm. Agrees with description of male except as follows: *Structure*. Eyes less divergent below. Clypeus protuberant over two thirds of eye width. Antennal scape reaching posterior margin of posterior ocellus; flagellum distally a little broader than scape, segments 2-9 wider than long to as wide as long, segment 10 about 1.5 times as long as wide. Basitibial plate with surface obscured by short appressed hair. *Surface*. Vertex with punctation like that of frons except close to ocelli. Propodeal triangle with transverse striae extremely fine. T5 and 6 and S2-5 with rather coarse punctures and hair bases. *Pubescence*. On head as described for male but darker, largely blackish. Upper margin of hind tibia beyond basitibial plate with hairs black. Prepygidial and pygidial fimbriae and many of lateral hairs on other terga, and hairs of S6 black.

Type material: Holotype male and allotype female: Brazil: Santa Catarina, Nova Teutonia, November 24, 1942 (Fritz Plaumann) [Lawrence]. Other specimens from the original series are believed to be in the collection at the Universidade Federal do Paraná, Curitiba, Brazil.

Etymology: This species is named after Fritz Plaumann, who collected in Santa Catarina for many years. Padre J. S. Moure provided the specific name on his labels about 1956, but has not continued work with this group. He also recognized its distinctiveness and provided an unpublished generic name.

Leioproctus (Sarocolletes) duplex new species

This species resembles other species of its subgenus except for having two instead of three submarginal cells. It is considerably smaller than *L. (S.) rufipennis* and differs also in details of sculpturing and terminalia. (Fig. 7a-h)

Description: Nonmetallic black with punctate but shining integument and broadly translucent tergal margins; pubescence mostly brownish white, forming conspicuous apical tergal bands.

Male: Length 7-8 mm; forewing length 5.6-5.9 mm. *Structure*. Eyes converging below except upper extremities which converge slightly above. Ocelli small; ocelloccipital distance over twice ocellar diameter and equal to interocellar distance

which is less than ocellocular distance; distance from anterior edge of median ocellus to posterior edge of vertex about equal to that to antennal bases. Vertex behind ocelli convex. Clypeus not protuberant; clypeoantennal distance slightly more than diameter of antennal socket; malar area linear. Labrum twice as broad as long, basal three fifths convex, convexity divided by longitudinal median depression; distal half with short hairs basal to fringe, basal half smooth, shining. Antenna almost reaching anterior ocellus; flagellum not reaching tegula, segment 1 about as broad as long, 2 and 3 much broader than long, 4-10 slightly broader than long, 11 longer than broad. Propodeum in profile declivous, "subhorizontal" part very steeply sloping, slightly shorter than metanotum; groove defining triangular area not pitted. Wings hairy throughout, basal vein slightly distal to cu-v; two submarginal cells, second (2+3) a little shorter than first, receiving first recurrent vein about one seventh of cell length from base; jugal lobe of hind wing slightly exceeding level to cu-v. Basitibial plate rounded at apex, surface with few short hairs. Hidden sterna and genitalia as in Fig. 7a-e. *Surface.* Face below antennal level rather dull because of small, dense punctures; rest of head and thorax with punctures well separated, ground between them smooth, shining; genal area with small punctures; rest of head and thorax with punctures coarse, in most areas separated by about a puncture width; coarsest punctures on posterior part of vertex and discs of scutum, scutellum, and mesepisternum; large smooth impunctate area lateral to lateral ocellus and on hypoepimeral area; propodeal triangle shining but with some fine irregularities, and with a few fine transverse striae basally. Metasoma shining but surface finely roughened, punctures rather small, on terga separated by one or two puncture widths, on sterna by several puncture widths; posterior margins of T1-5 and S1-6 broadly depressed, impunctate. *Color.* Black, apical third of mandible dark red; under side of flagellar segments 3-11 brown; front tibia and tarsus red-brown; mid and hind tarsi dark brown; tegula and posterior margins of terga and sterna translucent yellow-brown. Wings light yellow-brown, veins and stigma brown. *Pubescence.* Pale yellow-brown, long, nearly hiding surface on lower half of face, erect on discs of terga and sterna, forming transverse preapical bands of decumbant hair partly hiding depressed margins of T1-5 and S2-6; T6-7 largely covered with similar hair but T7 with median bare area (see subgeneric description).

Female: Length 7.5 mm; forewing length 5.7 mm. Similar to male except as follows: *Structure.* Eyes only slightly converging below, minimal distance between them about equal to eye length. Labrum a little more than twice as broad as long; convexity stronger than in male, occupying little more than half of labral surface, only weekly depressed medially; distal third with few short hairs basal to fringe; surface dull. First flagellar segment about 1.5 times as long as broad. Basitibial plate more densely hairy but marginal carina exposed. Pygidial plate rounded at apex. *Surface.* Lower half of face slightly more coarsely punctate, like frons. Disc of scutum with large impunctate area, of scutellum with sparsely punctate area. S2-5 with coarse hair bases instead of fine punctures. S1-6 with only narrow impunctate depressed margins. *Color.* Entire mandible dark red. Legs largely dark brown. *Pubescence.* Shorter than in male, not hiding facial surface; area beyond basitibial plate with a few dusky hairs; upper margin of hind basitarsus with dusky hairs; short, erect white hairs on discs of T2-4; hairs of T5-6 reddish dusky, rather long; no pale band on T5; sternal scopa of very long, pale yellowish hairs on T2-5.

Type material: Holotype male, allotype female, and seven male paratypes: Argentina: Santa Fe Prov., Colonia Masoias, Departamento Garay, 22 October, 1942 (collector unknown) [Lawrence; two male paratypes, Buenos Aires].

Etymology: The species name, *duplex*, refers to the two submarginal cells.

Leioproctus (Holmbergeria) cristariae (Jörgensen)

Holmbergeria cristariae Jörgensen, 1912:100.

I am indebted to Dr. Ricardo Ronderos [La Plata] for the loan of two specimens (on one pin) bearing the collection and identification labels of Jörgensen (the latter, in Jörgensen's handwriting according to Arturo Roig-Alsina, reads *Holmbergia* (sic) *cristariae*), and a lectotype label by Ogloblin with the notation "el ejemplar superior." Since Ogloblin did not publish this lectotype designation, I hereby accept and validate it and have attached a label accordingly; the upper specimen on the pin is the lectotype. The lower specimen is the same species.

Leioproctus (Pygopasiphae) mourellus new species

This species is markedly smaller than *L. (P.) wagneri*, the other named species of the subgenus, and is further differentiated by the simple hind trochanters and tibiae of the male, the four or five teeth on the inner hind tibial spur of the female (instead of two or three, as in *L. wagneri*), and other variables as indicated in the subgeneric description. (Figs. 8a-f, 10h)

Description: Nonmetallic black, pubescence whitish or yellowish, forming apical tergal pale bands in male which are scarcely evident in female, but tergal surfaces of both sexes with white hair.

Male: Length 7-8 mm; forewing length 5.5 mm. *Structure.* Eyes converging below except for upper extremities which converge above. Ocellocipital distance about 1.8 ocellar diameters; interocellar distance nearly three ocellar diameters,

more than ocellocular distance; distance from anterior edge of median ocellus to posterior edge of vertex less than that to antennal bases. Vertex convex behind ocellar area. Apex of labrum broadly emarginate. Clypeus little protuberant, clypeoantennal distance 1.5 times diameter of antennal socket; malar area linear. Antennal scape not reaching anterior ocellus, first flagellar segment about 1.5 times as long as broad, succeeding segments progressively longer, middle segments about 1.8 times as long as broad. Pygidial plate shining, rounded posteriorly, defined by carina distally, not narrowed anteriorly. Hidden sterna and genitalia as in Fig. 8a-d, f. *Surface*. Punctures rather fine, mostly separated by two or more puncture widths of smooth ground but those of lower 3/4 of face, posterior margin of vertex, genal area, posterior margin of scutellum, side of propodeum and S6 dense; ocellar-ocular area, posterior central part of scutum, anterior central part of scutellum, much of hypoepimeral area, and propodeal triangle smooth, shining, impunctate. T1 and S1 and 2 with punctures especially fine, separated by many puncture widths. Posterior marginal zones of terga and sterna with punctures a little finer than elsewhere, sparse, not reaching margins proper, on S3-5 denser apically than elsewhere. *Color*. Black or brownish black, metasoma dark brown; apical half of mandible red; flagellum brown above, yellow-brown beneath; tegula translucent testaceous; tarsi, front and mid tibiae, apex of hind tibia yellow-brown. Wings clear, veins and stigma light-brown. Apical margins of T1-6 brownish translucent. *Pubescence*. Long and more or less erect, yellowish white dorsally, yellow on face, nearly white ventrally, hiding face below antennae, forming apical bands of appressed white hair on T2-4, bands weaker on T1, 5, 6, other parts of terga with rather sparse, sloping or suberect, rather long white hair; apical fringes of somewhat yellowish hair on S2-4, longer and denser on S5.

Female: Length 10-11 mm; forewing length 6.0-6.8 mm. Differs from description of male as follows: *Structure*. Inner margins of eyes scarcely converging below, upper parts converging above. Elevated basal part of labrum with strong transverse carina. Interocellar distance less than three ocellar diameters. Antennal scape reaching lower edge of median ocellus, first flagellar segment about 1.4 times as long as maximum width, second much broader than long, third about as long as broad, other segments slightly longer than broad. Pygidial plate minutely roughened, dull, apex rounded, lateral margins strongly diverging anteriorly, in dry specimens margins appear weakly carinate but cleared preparation shows carina only across apex of plate, elsewhere only a change of surface orientation and vestiture from bare flat plate to steeply sloping hairy surface. *Surface*. Head, especially clypeus, supraclypeal area, lower paraocular areas, and lower parts of genal areas with punctures coarser than in male, separated by about a puncture width. T1-4 except laterally with punctures extremely fine and widely separated; T5 with punctures much coarser and closer. S1-5 with punctures (or hair bases) coarser than in male but absent from basal part of each sternum which is minutely reticulate. *Color*. Flagellum brownish black, paler apically, under side of segments 3-10 light brown. Legs brown, anterior side of front tibia yellow-brown. *Pubescence*. White except yellow on dorsum of thorax, long on face but not hiding surface except for parts of paraocular area, not forming bands on metasomal terga but surfaces of T2-4 and base of 5 with appressed white hair not hiding surface; prepygidial and pygidial fimbriae light brown; sternal hairs whitish, only S5 with conspicuous fringe.

Type material: Holotype male, allotype female, eight male and three female paratypes: Argentina: Catamarca Prov., Andalgalá (IBP desert site), (J. L. Neff, collector). Primary types, [Lawrence]. Paratypes, [Austin], 4 males, 2 females; [Lawrence], 2 males, 1 female; [Buenos Aires], 2 males. All were at flowers of *Prosopis chilensis* except one male at *Prosopis flexuosa*. The holotype was taken on Oct. 18, 1973, the allotype on Oct. 22, 1973. Paratypes were taken on both of those dates and on Oct. 24 and 29, 1972.

Additional specimens: Two specimens taken with the paratypes are stylopized and sexually anomalous. Two females, also taken by J. L. Neff at the type locality on Oct. 29 and Nov. 4, 1972, on flowers of *Prosopis chilensis*, differ from the typical form in having the legs (except coxae and trochanters) and metasoma yellowish red [Austin]. A similar specimen from the same locality, Nov. 4, 1972, was taken on *Prosopis alba* by G. E. Bohart [Logan]. This appears to be a color morph of *L. mourellus*.

Etymology: The specific name is in honor of Padre J. S. Moure of Curitiba, Brazil, who recognized this species as new and left specimens with this indication in the collection of J. L. Neff, to whom I am indebted for the opportunity to study this and many other interesting Paracolletini.

Leioproctus (Halictanthrena) malpighiacearum (Ducke)

Halictanthrena malpighiacearum Ducke, 1907:364.

At least two "types" (cotypes) of this species exist, a male and a female [Berlin]. Since the female was described most fully, it is here designated as the lectotype. Its labels in Ducke's handwriting read "Barbacena 21-10-1905 Ducke" and "*Halictanthrena malpighiacearum* Ducke typ ♀." Other labels are "*Lonchopria malpighiacearum* Ducke, ♀, det. J. D. Alfken, 1928" and on red paper, "Typus." I have added a red lectotype label with the name and my name. The male, from the same locality, was collected on "8-11-1905."

Leioproctus (Protodiscelis) fiebrigi (Brèthes)

Protodiscelis fiebreigi Bréthes, 1909:246.

There are problems with the original description and type material of this species, the type species of *Protodiscelis*. The so-called female described as having simple mandibles (see Brèthes' generic description), simple hind tibial spurs, and short hairs on the hind tibia must have been a male. The "allotype" [Buenos Aires] is a male and appears to be in reality the holotype; I have added a label to that effect. It was probably labeled as the allotype by someone who recognized it as a male and did not check the characters given by Brèthes. The male described by Brèthes had yellow on the clypeus, lower paraocular areas, and pronotal lobes, unlike any American colletine bee. Probably it was a panurgine bee with retracted mouthparts so that Brèthes did not recognize it as an andrenid rather than a colletid bee. Brèthes' male specimen appears to be lost. In any case it is the "female" that he described in detail and that should carry the name. Clearly the "female" was the main specimen used in writing the generic description, the simple mandibles and large maxillary palpi being especially diagnostic.

The holotype ("allotype") lacks middle legs and one hind leg; the other hind leg was hanging loose and is now detached and glued to the label, which reads "San Bernardino, Fiebrig."

Leioproctus (Protodiscelis) spathigerus new species

This species resembles other species of its subgenus in appearance, but differs in having the middle tibial spur broad, sheath-like (Fig. 12m, n), and the hind tibial spurs slightly modified in the same direction. The male is unknown. (Fig. 12j-o)

Description: Nonmetallic black except for brownish areas as described below; brownish posterior margins of metasomal terga combine with slightly longer hair to suggest weak metasomal banding.

Female: Length 6 mm; forewing length 5 mm. *Structure*. Eyes rather slightly converging below except for subparallel upper extremities. Ocelloccipital distance nearly equal to ocellar diameter; interocellar distance about two ocellar diameters, slightly < ocellocular distance; distance from anterior edge of median ocellus to posterior margin of vertex only about half that to antennal bases. Vertex behind ocelli convex, not elevated. Clypeus not at all protuberant; clypeoantennal distance nearly twice diameter of antennal socket. Antennal scape not quite reaching anterior ocellus; flagellum short, wider than scape, segment 1 as long as broad, 2 and 3 about twice as wide as long and 4 nearly so, remaining segments wider than long except last which is about 1.3 times as long as wide. Propodeum in profile with base somewhat sloping, longer than metanotum. Forewing with basal vein meeting cu-v, submarginal cell 2+3 slightly shorter than 1, receiving first recurrent vein near base; apex of marginal cell sharply truncate with distinct appendage. Jugal lobe of hind wing slightly exceeding level of cu-v and about two thirds as long as vannal lobe measured from base. Basitibial plate with apex narrowly rounded, surface largely covered with short appressed hairs except for strongly carinate margins. Middle tibial spur almost as long as basitarsus, broad and flat, widest near middle, margins apparently entire although with a pattern of lines suggestive of teeth; hind tibial spurs similarly flattened but more slender, margins toothed, inner margin of inner spur finely pectinate. Pygidial plate rounded at apex, surface medially near apex convex, roughened, a broad, concave, shiny, marginal zone both laterally and posteriorly between convex area and strong marginal carina. *Surface*. Punctures of clypeus and supraclypeal area coarse, separated by several puncture widths of smooth, shining ground, except laterally where they become finer and close. Paraocular area unusually convex, shiny, with widely separated punctures similar to those of clypeus but finer. Frons with finer and closer punctures; vertex and genal area with very fine, widely separated punctures. Scutum with punctation of anterior and lateral parts similar to that of frons but center posteriorly, also scutellum, with coarser and more widely separated punctures like those of paraocular convexity. Disc of mesepisternum with similar coarse and widely separated punctures; other mesepisternal areas more finely punctate; ground between punctures of head and thoracic areas described above smooth and shining. Metepisternum and sides of propodeum minutely roughened, without distinct punctures. Propodeal triangle shining but minutely roughened. T1 and 2 shining with minute, widely separated punctures (few on T1) dorsally, more laterally; remaining terga with more but also minute punctures (and hairs), extending unmodified onto broad, depressed apical marginal zones. Sterna much more coarsely and closely punctured. *Color*. Integument black, undersides of flagellar segments 3-10 and tibial spurs light brown; mandible except base red; tegula and legs dark brown or brownish black (small segments of tarsi reddish brown); broad posterior margins of T1-4 and narrower margin on T5 translucent brown. Wings light brown, veins and stigma brown. *Pubescence*. Short, longest on sides of thorax (especially upper lateral part of propodeum), S2-5 and scopa, nowhere hiding surface. Hairs dull white on lateral and ventral surfaces and on bases of legs including femora, pale brown elsewhere, darker brown with longer hairs dusky on vertex, scutum, scutellum, T4-6 and sides of T2-3; scutum with extremely short, appressed brown hairs and sparse, longer, erect dusky hairs; scopal hairs around basitibial plate and beyond plate on upper margin of hind tibia blackish; T1 without hairs middorsally (as seen in profile);

preapical hairs of terga slightly longer than more basal hairs but not dense or pale enough to form distinct hair bands.

Type material: Holotype female and five female paratypes: Brazil: Estado de São Paulo, Rio Claro [Lawrence]. Two other female paratypes, same locality, one dated December, 1943, the other January, 1944 [Lawrence]. Additional specimens are in [Curitiba].

Comments: Padre J. S. Moure placed the species in a new genus because of the peculiar middle and hind tibial spurs, but the lack of other distinctions from *Protodiscelis* indicates its affinities. I consider *L. spathigerus* as a species of *Protodiscelis* remarkable only in this one character.

Etymology: The specific name of this species was provided by Padre J. S. Moure who labeled specimens before 1955. It means the bearer of a sheath, with reference to the broad, sheath-like middle tibial spur.

Leioproctus (Tetraglossula) anthracinus new species

In this black bee, the pubescence is all black or dusky, except dull whitish on the face and genal area; metasomal scopa of female also whitish. Because of its size and black aspect, it has been misidentified in collections as *L. (Hoplocolletes) ventralis*.

Description: Nonmetallic black with much black pubescence.

Male: Length 10-11 mm, forewing length 8-8.5 mm. *Structure*. Eyes slightly diverging below. Ocelloccipital distance about three ocellar diameters, interocellar distance over 2.5 ocellar diameters and shorter than ocellocular distance. Vertex behind ocelli raised, convex. Clypeus slightly protuberant (in side view less than half eye width); clypeoantennal distance more than diameter of antennal socket; malar area almost linear; genal area wider than eye seen from side. Antennal scape reaching middle of anterior ocellus; flagellum short, reaching pronotal lobe, slender basally but wider than scape distally, segment 1 1.5 times as long as wide, segments 2-10 wider than long, segment 11 about 1.3 times as long as wide. Second submarginal cell (2 + 3) about as long as first, receiving first recurrent vein near base. Basitibial plate with short hairs not obscuring surface. Hidden sterna and genitalia similar to those of *L. (T.) fucosus* (Fig. 13a-e) but S7 with upper apical lobes broader and hairier, lower preapical lobes hairy throughout and especially on mesobasal angles which are bare in *fucosus*; volsella longer than wide, apex acute although rounded. *Surface*. Punctures of head and thorax moderate sized, well separated by smooth ground; those of clypeus scarcely coarser than elsewhere on face and dense along lower margin; of mesepisternum and scutum coarser than elsewhere, on scutum separated by more than a puncture width; of vertex posteriorly and laterally, genal areas, and sides of propodeum with only minute, well separated punctures; large, shining impunctate area lateral to ocelli and occupying upper part of paraocular area; longitudinal impunctate zone in front of median ocellus. Scutellum with impunctate dorsolateral area. Propodeal triangle shining, with minor irregularities and a few transverse striae basally; pits in marginal groove transversely elongated. Metasomal terga with punctures separated by several puncture widths of shiny ground, on T1 and 2 only slightly smaller than those of clypeus, on other terga progressively finer; posterior marginal zones of terga and sterna broad, depressed, without or with scattered minute punctures. S2-5 with rather coarse, widely separated punctures on polished ground, S6 with surface minutely roughened between scattered punctures. *Color*. Black with flagellum (paler beneath), tegula, legs, and much of metasoma slightly brownish; tibial spurs dark brown; scape, genal area, side of thorax and propodeal triangle sometimes also brownish; mandible red preapically. Wings brown, veins and stigma dark brown. *Pubescence*. Dusky blackish, that of face and genal and hypostomal areas gray or dull whitish. S5 with strong black apical fringe, lateral hairs longest and curved mesad.

Female: Length 9.5-11.5 mm. Agrees with description of male except as follows: *Structure*. Inner margins of eyes about parallel. Genal area about as wide as eye in side view. Flagellar segment 9 about as long as broad, 10 over 1.5 times as long as broad. Basitibial plate with surface partly hidden by appressed hair. *Punctation*. Clypeal and supraclypeal punctures coarser than those of rest of face, dense on lower part of clypeus, largest punctures nearly as large as scutal punctures but much closer together; clypeus with irregular longitudinal median impunctate line; scutal and scutellar punctures, except for margins, separated by two or more diameters. T1-3 with only minute, widely separated punctures, larger and denser laterally; T4 with more punctures, especially laterally; T5 with abundant large punctures on minutely roughened ground. S1 almost impunctate, S2-5 with coarse, well separated punctures (bases of scopal hairs), S3-5 with surface minutely roughened at least in certain areas, S6 with dense small punctures apically, surface minutely roughened. *Color*. Distal half of mandible variably dark red. *Pubescence*. S2-5 with scopa of long, dull white hairs; S5 with dark apical fringe shorter than in male and largely hidden by pale scopal hairs.

Type material: Holotype male, allotype female, and seven male and five female paratypes: Brazil: Estado de São Paulo, São Carlos, April 1, 1956 (C. D. Michener) [Lawrence; a pair of paratypes, Curitiba]. One male paratype: Paraná, Curitiba, January 28, 1968; one male and two female paratypes: same locality, January 10 and 20, 1964, and April 11, 1963 (S. Laroca) [Lawrence].

Etymology: The specific name is a Latin adjective meaning coal black.

Leioproctus (Tetraglossula) fucosus new species

This species differs from other species of its subgenus by the partly to largely red metasoma. The pubescence is pale (light brown to whitish) except for some dusky hairs on the legs and metasomal apex of the female. In form and coloration this species is like females of *L. (Perditomorpha) brunerii*. (Figs. 13, 16f)

Description: Nonmetallic black with metasoma largely red; pubescence largely pale.

Male: Length 6.5-9.5 mm (holotype 9 mm), forewing length 5.5-7 mm (holotype 7 mm). *Structure*. Inner orbits parallel. Ocelloccipital and interocellar distances nearly three ocellar diameters, ocellocular distance slightly more. Vertex behind ocelli raised, convex. Clypeus scarcely protuberant (in side view less than half eye width), lower margin produced downward as rounded median lobe; clypeoantennal distance slightly less than diameter of antennal socket; malar area almost linear; genal area as wide as eye seen from side. Antenna as described for *L. (T.) anthracinus* but flagellar segment 11 sometimes (in holotype) over 1.5 times as long as wide. Second submarginal cell (in holotype) shorter than or equal to first, receiving first recurrent vein near base. Basitibial plate with short hairs not obscuring surface. Hidden sterna and genitalia as in Fig. 13a-e. *Surface*. Head and thorax with punctures of moderate size, surface between them smooth and shining; clypeal punctation not coarser than that of adjacent areas; extreme side of clypeus near mandibular base impunctate; ocellar area, laterally to eye, and area around summit of eye and down along inner orbit with only widely separated, minute punctures but convex part of vertex behind ocelli strongly punctured; disc of mesoscutum and scutellum with punctures more widely separated than on head; punctures coarsest on convex part of vertex and discs of mesoscutum, scutellum, and mesepisternum; posterior part of disc of scutum and either side of midline of scutellum with irregular impunctate areas; margins of these sclerites more finely and coarsely punctate. Propodeum with triangle shining but weakly, minutely roughened; rest of surface with minute roughening, strongest posterolaterally where surface is dull and punctation strong; punctures fine anterolaterally. T1 disc with rather fine punctures separated by three or four puncture widths; remaining tergal discs with punctures finer and somewhat closer; posterior marginal depressed areas T1-6 broad, with much finer punctures than discs, becoming impunctate near margins proper. Pygidial plate shining, finely and irregularly roughened. S1-5 shining but minutely roughened with widely separated hair bases; S1-4 with broad, hairless and impunctate posterior margins. *Color*. Head and thorax black, mandibles and legs reddish brown with basal parts darker; flagellum brown, black on upper surface of first three or four segments; posterior lobe of pronotum dark reddish brown; tegula translucent yellow brown. Wings slightly brown, veins and stigma brown. Metasoma with sterna and bases and apices of terga yellowish red, broad central, ill-defined, transverse zone of each tergum dusky brown to blackish, the zone on T2 ending in large lateral black spot; anterior terga generally with more yellowish red than posterior terga so that dusky zone is sometimes absent or weak on T1 and rather narrow on T2; rarely terga brownish black except for yellowish posterior bands; depressed marginal zones of T1-5 broadly translucent yellowish. *Pubescence*. Ochraceous on dorsum and on tibiae and tarsi, dull whitish elsewhere, abundant but not entirely hiding surface on face and genal area, elsewhere sparser except abundant, short, of uniform length, rather dusky and not forming bands on terga; S1-5 with long, sparse hair, not forming bands except for long apical fringe on S5, its hairs longest laterally and directed mesad.

Female: Length 8.5-9 mm. Agrees with description of male except as follows: *Structure*. Ocelloccipital and interocellar distances about 2.5 ocellar diameters. Clypeus more protuberant (more than half eye width, lower margin with truncation about one third as wide as clypeus, median marginal lobe absent. Pygidial plate with apex broadly rounded. *Punctation*. Clypeus with longitudinal median impunctate line; impunctate areas of scutum and scutellum larger than in male; terga more sparsely and minutely punctate than in male, T1 almost impunctate, smooth and shining. S2-5 with hair bases very large. *Color*. Flagellum dark brown above, lighter brown beneath. Posterior lobe of pronotum almost black. *Pubescence*. Slightly less dense on face than in male; short tergal pubescence sparse on T1; outer surfaces of fore and mid tibiae with hairs dusky in some lights; outer margin of hind tibia and basitarsus with blackish hairs, leg scopa otherwise yellowish white; prepygidial and pygidial fimbriae dusky; metasomal scopa yellowish white.

Type material: Holotype male, allotype female, and 55 male and 7 female paratypes: Brazil: Estado de São Paulo, São Carlos, April 1, 1956 (C. D. Michener) [Lawrence; paratypes in Curitiba, Washington, New York].

Other material: 16 males, 4 females from Brazil: Estado de Pará, Cachimbo, June, 1962 [Lawrence]. In these specimens the antenna and legs are largely red, the metasoma is entirely yellowish red except the blackish spot at side of T2 or T4-7 of male are largely blackish, and the dusky and blackish hairs are paler than in specimens from São Carlos.

Etymology: The specific name is a Latin adjective meaning painted or colored, with reference to the usually partly or wholly red metasoma.

Leioproctus (Nomiocolletes) simplicicrus new species

This species is described here because it pos-

sesses some of the attributes of *Nomiocolletes* while at the same time possessing features of the probably primitive *Leioproctus* such as *Chilicolletes*. The small size, simple hind legs and relatively slender metasoma distinguish the species immediately from other *Nomiocolletes*. Additional specific characters are indicated in the subgeneric description. (Fig. 18)

Description: Black, nonmetallic, with largely red legs and greenish yellow apical integumental metasomal bands.

Male: Length 8 mm; forewing length 6.8 mm. *Structure*. Eyes converging below except for subparallel upper extremities. Ocelloccipital distance over three ocellar diameters; interocellar distance almost three ocellar diameters, less than ocellocular distance; distance from anterior edge of median ocellus to posterior edge of vertex about equal to distance to antennal bases. Vertex broad but not raised behind ocelli. Clypeus flat, not protuberant as seen in profile; clypeoantennal distance slightly greater than diameter of antennal socket; malar area linear. Antennal scape short, apex not closely approaching anterior ocellus; flagellar segment 1 about as long as broad, segment 2 about 1.3 times as long as broad, middle segments over 1.5 times as long as broad, segments 2-11 with broad zone on inner side marked by three longitudinal ridges and sparse rather than dense minute hairs. Pygidial plate absent, represented by undefined longitudinal zone more shiny, less closely punctate, and less hairy than adjacent areas. Hidden sterna and genitalia as in Fig. 18a-e. *Surface*. Body closely and strongly punctured; areas with minutely roughened interspaces between punctures, mostly less than a puncture width, behind summit of eye, scutal disk and especially front end of scutum, mesepisternum below scrobal suture, and posterior surface of propodeum, metasomal sterna and extreme sides of metasomal terga; punctures coarsest on scutum and mesepisternum below scrobal suture, finest on metasoma; propodeal triangle minutely roughened, dull, subhorizontal surface with roughly 16 irregular longitudinal rugae (lateral ones sloping mesad) separating small depressed areas that are not delimited posteriorly; metasomal terga and sterna with narrow impunctate posterior margins, terga with colored bands mostly twice as wide as impunctate bands. *Color*. Black, mandible infuscated reddish; tegula infuscated dark brown, black anteriorly; legs red, mid basitarsus yellowish. T1-5 with apical pale yellow bands; basal two-thirds of each band punctate on T1, 2; only a few punctures in band of T5; T3-4 intermediate. S1-6 infuscated dark reddish brown. Wings dark brownish, veins and stigma brownish black. *Pubescence*. Short, weak, dull yellowish, not forming tergal bands; S5 with apical fringe of yellowish hair. Lower half of face with golden hair partly obscuring surface; metasomal tergal hair especially short.

Holotype male: Perú: Loreto Prov., Pucallpa, 200 m altitude, June 20-30, 1965 (J. Schunke) [Lawrence]. The wings of the specimen were badly folded and stuck together so that the venation was invisible; those of one side were removed, cleaned in water, dried, and glued to a card below the specimen.

Etymology: The specific name is formed from the Latin *simplex*, simple, plus *crus*, leg, with reference to the ordinary hind leg which contrasts with that of other species of the subgenus.

Lonchorhyncha ecuadoria (Friese) new combination

Diphaglossa ecuadoria Friese, 1925:10.

This species, the only species of its genus, has not been reported since its description from one female in 1925. It is now known from both sexes (one specimen each). The following are descriptive notes to supplement Friese's description and the generic description. (Figs. 22a-i, 23a-d, 31c)

Description: Female: Length 12.5 mm; forewing length 8.5 mm. *Structure*. Inner orbits converging above at upper ends, upper ends of eyes conspicuously bulging above adjacent part of vertex; rest of inner orbits feebly converging below; distance between eyes least at upper ends. Ocelloccipital distance about 0.5 ocellar diameters; interocellar distance slightly over an ocellar diameter and about 0.6 times ocellocular distance; distance from lateral to median ocellus about 0.3 ocellar diameters. Antennal scape reaching median ocellus, apex about as wide as flagellum. Pygidial plate narrowly rounded-subtruncate at apex, lateral marginal zone shining and slightly depressed relative to median, roughened, elevated zone, margin proper sharply carinate. *Surface*. Clypeus with distinct punctures mostly separated by two or three puncture widths of minutely roughened ground, lower lateral part of clypeus more shining and impunctate (lower median part of clypeus destroyed). Punctures of head and thorax otherwise minute and inconspicuous because of minutely roughened, dull ground. Metasoma slightly more shiny than thorax but surface minutely roughened; punctures minute, well separated, coarser on sterna than terga but basal parts of S2-4 almost without punctures and hairs; T1-4 and S1-5 with narrow, apical, hairless, rather shiny margins. *Color*. Black, distal part of mandible red brown; tegula brown; legs brownish black basally, progressively lighter brown distally so that small tarsal segments are almost testaceous; apices of front and middle femora and bases of corresponding tibiae, also anterior side of front tibia, light brown; extreme apical margins of terga and sterna somewhat pallid. *Vestiture*. Hairs of head, scape, thorax, first metasomal tergum, coxae, trochanters, and femora long, fine, plumose, pale fulvous; longest hairs of vertex, paraocular areas, scape, and dorsum of thorax and T1 with distal parts dusky or blackish; hairs dense but not completely obscuring surface except around antennal base and side of propodeum; hairs of clypeus and genal area shorter,

nearly simple, sparse; distal margin of clypeus with fringe of long yellow hairs; mandibular hairs yellow; tibial and tarsal hairs yellow-fulvous, coppery on under sides of tarsi, dusky on outer sides of fore and mid tibiae and basitarsi, black on outer side of hind tibia and basitarsus (also on apex of femur). Propodeal triangle conspicuous because of being hairless. Wings yellowish dusky, distal margin darker, veins and stigma brownish black. T2-4 uniformly covered with short black hair except for apical pale fulvous band on T4. T5 and T6 with long, dense, plumose dusky fulvous hair. Sterna with rather long yellowish fulvous hair, coppery apically on S4 and especially on S5 and 6, forming dense apical bands on S2-5.

Male: Length 11 mm; forewing length 8 mm. Agrees with description of female except for usual features and the following: *Structure*. Inner orbits more strongly converging below so that eyes are as close below as at upper ends. Ocelloccipital distance nearly equal to ocellar diameter; distances between ocelli slightly more than in female. Antennal scape not quite reaching median ocellus. Pygidial area described for the genus. S6 rounded posteriorly with longitudinal median depressed, almost hairless area. *Surface*. Clypeal punctures large, indistinct, shallow, so that surface is vaguely reticulate and longitudinal median area slightly depressed; lower part not as smooth as in female, whole clypeus dull like much of head and thorax; upper paraocular area and vertex more shining than in female. Metasoma with surface shining, little roughened, with punctures coarser than in female, on terga fine and separated by over a puncture width, on sterna coarser, more uniformly distributed than in female, widely separated, fine and close only on S6. *Color*. Legs darker than in female, small tarsal segments brown; femora and tibiae black or brownish black except for brown anterior side of front tibia; apical margins of terga and sterna brown. *Vestiture*. Hair of head and thorax fulvous (possibly faded in female), many hairs of vertex, scape, paraocular area, and scutum largely dusky or black instead of only black tipped; femoral hairs (especially on mid femur) short, not long as in female; clypeal fringe less prominent than in female; labrum with apical fringe of coppery bristles; tibial and tarsal hairs as described for front and mid legs of female. T2-4 and base of T5 with short black hair, short and fulvous on distal half of T5, and on T6 and 7, T7 with a few long hairs arising on either side of apex of pygidial area. S1-3 with sparse moderately long yellowish hair, shorter and somewhat dusky on S4, and 5; S6 with denser short fulvous hair except on longitudinal median depressed area.

Holotype female: Guayaquil, Ecuador, April, 1923, on *Cucurbita* (Buchwald) [Berlin]. The mouthparts including the labrum of the female type have been removed at some time and in the process the lower part of the clypeus was largely broken off. These parts apparently have been lost; at least they cannot be found in the Berlin museum.

Other material: One male, Saraguro, south of Cuenca, Azuay, Ecuador, Nov. 29, 1970, 2900 m altitude (L. Peña) [New York].

Comments: The male and female are so similar in appearance and in the remarkable cephalic generic characters that there can be no doubt that they are conspecific.

***Eulonchopria (Eulonchopria) oaxacana* Michener**

The only Central American record for the genus is as follows: One male and one female, Nicaragua: 1 mi (1.6 km) north of Ciudad Darien, Matagalpa Province, 500 m altitude, 25 Sept. 1975, on *Acacia* (J. L. Neff) [Austin].

***Lonchopria (Lonchoprella) annectens* new species**

This small, dull species has a *Leioproctus*-like tibial scopa, unique in *Lonchopria*. (Figs. 24, 31e)

Description: Nonmetallic black with pubescence largely pale, sparse but widely scattered on metasomal terga so that tergal bands are absent.

Male: Length 7.5-8 mm, forewing length 5.5-5.7 mm. *Structure*. Eyes strongly converging below except for upper extremities which converge above. Ocelloccipital distance about 1.8 ocellar diameters; interocellar distance nearly three ocellar diameters, greater than ocellocular distance; distance from anterior edge of median ocellus to posterior edge of vertex little more than half that to antennal sockets. Vertex behind ocelli slightly raised, convex. Clypeus protruding less than half of eye width in front of eye; clypeoantennal distance greater than diameter of antennal socket; malar area extremely short, almost linear. Labrum over twice as broad as long, apex somewhat produced, narrowly rounded; basal half elevated, convex, shining impunctate, depressed medially so that elevation is weakly binodulose; apical fringe shorter than labrum. Mandible with rounded preapical ventral angle and with strong preapical tooth on upper margin (Fig. 24j). Glossal lobe about as long as basal width; labial palpus less than one third as long as prementum; maxillary palpus with most of last two segments beyond apex of galea. Antennal scape not reaching anterior ocellus; flagellum reaching scutellum, as wide as widest part of scape, of uniform width, first two segments subequal in length, slightly longer than broad, segments 3-10 about 1.5 times as long as broad, segment 11 nearly twice as long as broad. Line margining propodeal triangle unpitted or finely pitted anterolaterally. Second submarginal cell with posterior margin longer than that of third; closed cells of wings with hairs sparse, especially basal to basal vein and cu-v; jugal lobe of hind wing reaching or exceeding cu-v, over two thirds as long as vannal lobe. Basitibial plate shiny, hairless, defined by carinae, apex rounded. S6 with broad gentle longitudinal median convexity, shiny and with few hairs in basal two thirds, closely punctate with diverging hairs

laterally; apex medially produced (if transparent hairless margin is ignored), rounded. T7 rounded, densely hairy laterally, with shiny, nearly hairless (but punctate) dorsal area which is narrowed posteriorly. Terminalia as in Fig. 24a-e. *Surface*. Clypeus with distal third impunctate except laterally, the rest punctate, closely so in upper part of depressed median area, shiny with punctures separated by more than a puncture width on convex lateral areas; large triangular part of supraclypeal area nearly impunctate, shining; rest of head finely and closely punctate, longitudinally strigose punctate on frons. Thorax with punctures mostly coarser than those of head, separated by a puncture width or more on anterior half of scutum, rest of scutum (except laterally) and disc of scutellum impunctate, shining; mesepisternum coarsely punctate, lower half vertically strigose, hypoepimeral area impunctate; propodeum at sides coarsely and shallowly punctate, posterior dorsolateral area with large, shiny, nearly impunctate region lateral to triangle, triangle smooth and shiny. Metasomal surface shining but minutely roughened; widely separated minute punctures on terga, smaller on broad, depressed, posterior tergal margins; scattered coarser punctures on sterna. *Color*. Black, apex of mandible and of labrum reddish; distal parts of legs, depressed margins of terga, sterna, brownish black; under side of flagellum dark brown; tegula transparent testaceous; tibial spurs testaceous; wings clear with veins and stigma brown. *Vestiture*. Dull grayish white, dusky on apicolateral parts of T7; face with hairs long and white, dense enough to partly obscure surface, those arising near base of clypeus directed downward and nearly hiding clypeus; hypostomal area with long white hair; impunctate parts of scutum and scutellum hairless; T1 with erect hairs similar to those of thorax, T2-5 and apex of T1 with sparse, appressed white hair in addition to sparse suberect hairs that appear dusky in some lights, white in others; S1-5 with hair denser on margins, thus forming apical fringes, that of S5 especially dense and slightly yellowish; lateroapical areas of T7 with dense, short, dusky hairs.

Female: Length 9 mm, forewing length 6.5 mm. Agrees with description of male except for usual sexual features and the following: *Structure*. Ocelloccipital distance about one ocellar diameter. Labrum about twice as broad as long, basal two fifths strongly elevated to strong transverse carina. Mandible without ventral, preapical expansion, preapical upper tooth small. Antennal scape reaching beyond middle of median ocellus; first and tenth flagellar segments longer than broad, second and third broader than long, fourth to seventh about as long as broad, eighth and ninth slightly longer than broad. Basitibial plate mostly hidden by short hair but marginal carinae exposed, apex blunt pointed; outer hind tibial spur simple, untoothed. *Femoral scopa sparse, hairs anterior to femoral corbicula with a few long apical branches of about equal length, no single rachis; hairs posterior to femoral corbicula simple except for five or six long basal hairs with apical and preapical lateral branches directed distad; trochanteral hairs sparse, curved apicad, with short, sparse branches distally, directed distad. Tibial scopal hairs sparse, not hiding surface, those on lower margin of tibia curved distad and upward, these and those of most of outer surface of tibia with long apical and subapical branches and no recognizable distal rachis, those of upper margin with lateral branches directed distad along a strong rachis. Hind basitarsis with hairs on outer surface rather sparse, a little longer than those of inner surface, so that superficially the outer basitarsal surface resembles the outer tibial surface. Surface*. Clypeus punctate throughout, lower two fifths and broad convex lateral area sparsely so and shining. Mesepisternum more finely punctate, not strigose, punctures of lower part separated by a puncture width or more of dull, minutely roughened surface. Dorsolateral part of propodeum shining, with widely separated punctures. *Color*. Labrum red. Mandible, clypeus, sides of thorax, legs, and metasoma reddish black. Under side of flagellum brown. *Vestiture*. Facial hairs less dense than in male, not hiding surface. Hair on outer side of front tibia dusky; on outer sides of mid and hind tibiae, on apex of hind femur, and on outer side of hind basitarsus black; sparse suberect hairs on terga blackish, dense blackish hairs forming prepygidial and pygidial fimbriae and also on S6.

Type material: Holotype male, allotype female, and two male paratypes: Argentina: Santiago del Estero Prov., Depto. de Matará, Desvio 511, 24 October, 1928 (M. Gómez) [Lawrence, one paratype, Buenos Aires]. One male paratype, Santiago del Estero Prov., Las Termas, on *Prosopis alba*, Oct. 11, 1972 (G. E. Bohart) [Logan]. One male paratype, Catamarca Prov., Colpes, on *Zucagnia*, Oct. 29, 1972 (G. E. Bohart) [Logan]. One male paratype, Catamarca Prov., Andalgalá, on *Prosopis alba*, Oct. 25, 1972 (G. E. Bohart) [Logan].

Etymology: From the Latin *annectens*, meaning linking or joining, with reference to the similarity of this species both to *Leioproctus* and *Lonchopria*.

Lonchopria (Biglossa) longicornis new species

This is a moderate sized, rather slender nonmetallic species. The beveled preapical tooth of the male mandible is a particularly distinctive feature. (Fig. 27)

Description: Nonmetallic black with pubescence largely pale, forming narrow basal and apical tergal bands in female. Flagellum of male with all segments more than twice as long as broad.

Male: Length 8-11 mm; forewing length 7.0-7.7 mm. *Structure*. Eyes strongly converging below except for upper extremities which converge above. Ocelloccipital distance about 1.5 ocellar diameters; interocellar distance over 2 ocellar diameters and about equal to ocellocular distance; distance from anterior edge of median

ocellus to posterior edge of vertex much less than to antennal sockets. Vertex behind ocelli raised, convex. Clypeus scarcely protuberant, protruding less than half eye width in front of eye; clypeoantennal distance about equal to diameter of socket; malar area linear. Labrum twice as broad as long with a pair of strong round, shining, submedium convexities near base; apical margin medially truncate. Mandible with strong preapical ventral angle and with beveled preapical tooth (Fig. 27f). Glossal lobe about as long as wide; labial palpus less than half as long as prementum; maxillary palpus extending beyond apex of galea. Antennal scape reaching anterior ocellus; flagellum reaching base of metasoma, not as wide as scape, slightly tapering except last segment which is slightly broader than penultimate one, adjacent segments all subequal in length but lengths increasing progressively toward apex, basal segment near 2.5 times as long as broad, distal ones well over three times as long as broad. Line margining propodeal triangle strongly pitted. Second submarginal cell with posterior margin equal to or slightly shorter than posterior margin of third; basal cells of wing with hairs sparse, cells first Cu of forewing and Cu of hind wing nearly hairless, cell R of both wings with large hairless areas; jugal lobe of hind wing not reaching level of cu-v, about three fifths as long as vannal lobe measured from wing base. Basitibial plate with hairs not hiding surface, with strong carina, highest apically, on posterior margin but undefined on anterior margin. S6 with longitudinal ridge, narrow and bare basally, broad and hairy apically toward roundly truncate or weakly emarginate apex of S6. T7 densely hairy apically, apparently rounded, basally with shiny bare area tapering to point well before apex of T7. Terminalia as in Fig. 27a-e. *Surface.* Lower two fifths of clypeus convex, shining, impunctate except near margin; sublateral part of clypeus with convexity continued upward but not reaching summit of clypeus and with scattered hairs and coarse punctures; supraclypeal area shiny and impunctate except laterally; upper depressed, central part of clypeus about as long as broad, closely punctate; rest of head strongly but less coarsely punctured, more finely so around ocelli and lateral to them than elsewhere, nearly impunctate near inner orbits, ground between punctures minutely lineolate; scutum and scutellum with punctures coarser, close marginally but centrally, especially on posterior median part of scutum, separated by more than a puncture width of shining ground; rest of thorax and metasomal terga with coarse punctures, finer than those of scutum, mostly separated by about a puncture width (less on much of mesepisternum) of shining but minutely roughened ground; lower part of hypoepimeral area impunctate. Propodeal triangle shining, basally with a few fine, weak, transverse striae. T1-5 with marginal bands slightly depressed, translucent, impunctate or with scattered fine punctures basally. S1-5 with minute, widely scattered punctures on minutely roughened ground; margins smooth. *Color.* Black, flagellar segments 2-10 light brown beneath, 11 darker brown beneath; distal tarsal segments, mandibular apex and spot on tegula brownish; margins of T1-6 and S1-5 translucent brown. Tibial spurs testaceous. Wings slightly dusky, veins and stigma brownish black. *Vestiture.* Pubescence long, obscuring but not completely hiding face, almost as long on T1-3 as on thorax, progressively shorter on posterior terga, forming weak white apical bands on sides of T2 and on T3-5. Pubescence dull white, dusky on vertex; black on discs of scutum and scutellum; black hairs intermixed, mostly preapically, on T3 and 4; most hairs of disc of T5 black; T6-7 with hairs blackish brown; S2-4 with long white apical fringes, S5 with similar but denser and slightly yellowish fringe, S6 with short, mostly erect, yellowish hair radiating in all directions from distal median elevated area.

Female: Length 10-11 mm; forewing length 8 mm. Agrees with description of male except for usual sexual features and the following: *Structure.* Vertex somewhat shorter and less raised behind ocelli than in male. Labrum more than twice as broad as long, almost entire surface strongly convex with narrow longitudinal depression separating two weak convexities, only narrow apical margin thin, depressed, and bearing labral fringe; apex rounded. Mandible unmodified. Antennal scape reaching posterior ocellus; flagellum distally slightly wider than scape, segment 1 over 1.5 times as long as wide, 2 wider than long, 3 about as long as wide, 4-10 progressively longer so that middle flagellar segments are slightly longer than broad (as long as broad in some positions). Basitibial plate fully delimited, apex rounded, surface hidden by dense short hairs. Pygidial plate with apex rounded. *Surface.* Lower as well as lateral convex parts of clypeus smooth, shining, with coarse punctures separated by a puncture width or more; lateral convexity reaching summit of clypeus; smooth impunctate part of supraclypeal area small (less than one third as wide as supraclypeal area), convex, oval or widened at lower end; posterior median part of scutum impunctate; side of thorax (including side of propodeum) with punctures almost as close as they can be (except for impunctate lower part of hypoepimeral area). Propodeal triangle slightly shining, basally sometimes with fine, weak, transverse striae. T1 with punctures rather coarse (slightly finer than those of side of thorax), separated by an average of about a puncture width, much finer near posterior margin; remaining terga finely punctate, like marginal zone of T1; posterior marginal, translucent, nearly impunctate zones extremely narrow; bases of sterna with punctures fine like those of terga but distal parts much more coarsely punctate, margins narrowly depressed, smooth, translucent. *Color.* As described for male (eleventh flagellar segment absent); brownish margins of sterna and especially

terga extremely narrow. *Vestiture*. Pubescence not conspicuously long, mostly not obscuring surface, only basal half of T1 with long hairs like those of thorax; T1-4 with narrow apical bands of dense white hairs, on T1 sometimes broken medially, on T4 slightly wider than on other terga; T2-5 with narrow postgradular bands of white hair, commonly hidden under preceding terga; hair of head dull white (yellowish on mandibles, labrum, lower margin of clypeus) except black across vertex behind ocelli; hair of scutum and scutellum black except for dull white margins; rest of thorax with hair dull white except for black (sometimes absent) on upper part of mesepisternum, small laterobasal part of propodeum, and center of metanotum; hairs of tibiae and especially tarsi yellowish, coppery to dusky on outer sides of mid and hind tibiae, those of apical truncation of hind femur and vicinity of basitibial plate blackish; T1 with long dull whitish hair on basal half, rest of terga, except for white bands described above, with hairs blackish, short except for strong, dense, pygidial and prepygidial fimbriae, sterna with hairs yellowish white, forming long preapical white fringes on S2-4 and even longer, dense, yellowish fringe, similar to that of male, on S5.

Type material: Holotype male, allotype female, and one male paratype: Argentina: Catamarca Prov., Ruta 4 five km south of El Rodeo, 1450 m altitude, Feb. 8, 1984 (R. B. Roberts) [Lawrence; paratype, New Brunswick]. Seven female paratypes: Catamarca Prov., Andelgala (Internat. Biol. Prog., J. L. Neff) Mar. 14 and 19, 1973; Jan. 30 and Oct. 10, 1974, on flowers of *Solanum*; two female paratypes: same locality, Jan. 26, 1974, on flowers of *Baccharis* [Austin, one at Lawrence, two at Buenos Aires].

Lonchopria (Biglossa) robertsi new species

This small species is easily recognized in the female by the rather uniformly spread pale hair on the dorsum of the metasoma and in the male by the strongly bidentate T7. (Figs. 28, 31g)

Description: Nonmetallic black with pubescence largely pale, forming apical tergal bands in male but in female uniformly spread over T2-4 so that tergal bands are absent. T7 of male and pygidial area of female ending in two strong spines (Fig. 28j).

Male: Length 7-9 mm, forewing length 6.5-8.0 mm (7 mm in holotype). *Structure*. Eyes strongly converging below except for upper extremities which converge above. Ocelloccipital distance about 1.5 ocellar diameters (little over one diameter to beginning of declivity); interocellar distance 2.5 ocellar diameters, greater than ocellocular distance; distance from anterior edge of median ocellus to posterior edge of vertex less than to antennal sockets. Vertex behind ocelli raised, convex. Clypeus protruding over half of eye width in front of eye; clypeoantennal distance greater than diameter of socket; malar area linear. Labrum slightly less than twice as broad as long, basal half convex with fine punctures; apical margin medially sub-truncate. Mandible with rounded preapical ventral angle and with preapical angle but no distinct tooth on upper margin (Fig. 28g). Glossal lobe over twice as long as basal width; labial palpus less than half as long as prementum; maxillary palpus extending to apex of galea. Antennal scape almost reaching anterior ocellus; flagellum reaching little beyond tegula, as wide as scape, of uniform width, all segments longer than broad, first two segments slightly shorter than others, middle segments about 1.5 times as long as broad, last segment longer than others. Line margining propodeal triangle only minutely pitted. Second submarginal cell with posterior margin about equal to that of third; closed cells of fore wing hairless except a few hairs in distal cells, of hind wing similar but with few minute hairs; jugal lobe of hind wing reaching level of cu-v or nearly so, roughly two thirds as long as vannal lobe. Basitibial plate shiny, hairless, defined by carinae, apex narrowly rounded. S6 as described for *L. longicornis* but longitudinal ridge feeble. T7 strongly bidentate (Fig. 28j), densely hairy laterally but nearly bare elsewhere. Terminalia as in Fig. 28a-e. *Surface*. Clypeus as described for *L. longicornis* but sublateral convexities broader, almost impunctate and hairless; supraclypeal area with elevated, triangular (pointed above), impunctate region, sides closely punctate; upper, depressed, central part of clypeus longer than broad, closely punctate; rest of head less coarsely punctate, more finely so behind and lateral to ocelli where some areas have only rather sparse, small punctures, strip along inner orbit nearly impunctate; ground between punctures shining, minutely roughened on frons; thorax and metasomal terga more coarsely punctured than head, punctures separated by more than a puncture width of smooth, shining ground on discs of scutum and scutellum, and on posterior and dorsolateral surfaces of propodeum, elsewhere on thorax closer and interspaces minutely roughened; lower part of hypoepimeral area impunctate; T1-3 with punctures somewhat finer than on most parts of thorax and mostly separated by over a puncture width of smooth, shining ground; T4-6 with punctures progressively coarser and closer. Sterna with small punctures separated by minutely roughened ground. Propodeal triangle shining, minutely transversely roughened. T1-6 with marginal zones depressed, with well separated small punctures. *Color*. Black, apex of mandible, labrum, and of tibiae brown; tarsi brown but mid and hind basitarsi and sometimes other segments infuscated; tegula largely brown; posterior margins of T1-4 weakly brownish, of T5-6 translucent brownish, of S1-6 and apex of S8 light brown; T7 variably red brown. Tibial spurs pallid. Wings clear, veins and stigma brown. *Vestiture*. Pubescence long, largely obscuring surface on punctate parts of face, on T1 as long as on thorax but shorter on rest of metasoma, forming apical bands of appressed white hair on T1-5, weakly at sides of T6, and strongly on S2-5; elsewhere more or less erect. Hair white

on lower part of face and ventral surfaces of head and thorax, elsewhere (except for white metasomal bands) dull yellowish white except as follows: sometimes a few dusky hairs laterally on vertex (not in holotype); discal hairs of T3-5 and base of T6 dusky; T6 and 7 with hairs largely pale coppery. Lateral areas of T7 with short, dense hairs. Discal hairs very short on S3-6 but white apical fringes long on S3-5; hairs of S6 as in *L. longicornis*.

Female: Length 9-10 mm, forewing length 7.7 mm. Agrees with description of male except for usual sexual features and the following: *Structure*. Vertex shorter and less raised behind ocelli, ocelloccipital distance little more than ocellar diameter. Labrum less than twice as broad as long (Fig. 28i), apex rounded. Mandible nearly as broad preapically as at base (Fig. 28f). Antennal scape nearly reaching posterior ocellus, flagellum distally slightly wider than scape, segment 1 longer than broad, 2 broader than long, 3-9 about as long as broad. Basitibial plate with surface hidden by dense, short hairs. Pygidial plate with apex emarginate, produced to strong tooth at each side. *Surface*. Posterior median part of scutal disc, on each side of punctate median zone, nearly impunctate. Metasomal punctures much finer than those of most parts of thorax except on T5 and apices of sterna. *Color*. Apices of mandible and labrum red; basitarsi and apices of tibiae not brown; underside of flagellar segments 3-10 brown; tergal margins not brown or translucent (weakly brownish in some paratypes); pygidial plate reddish black. Tibial spurs testaceous, reddish brown on posterior leg. *Vestiture*. Not obscuring surface, not forming tergal hair bands. Hair of vertex dusky, of thoracic dorsum fulvous with scattered black hairs on scutum and scutellum. T1 with erect pale fulvous hair except posteriorly; T1 at apex and T2-4 with appressed pale fulvous hair spread over tergal surfaces and sparse, often dusky, more erect hairs, longer and blacker on T4; T5-6 with dense black hairs that appear light gray in some lights. S2-5 with long apical white fringes, otherwise sterna with fulvous hair. Hair of legs yellowish white, darker on inner surfaces of tibiae and tarsi, brown on outer surfaces of tibiae; scopa brown, grading to white on lower margin of tibia.

Type material: Holotype male, allotype female, eight male and one female paratypes: Argentina: Tucumán Prov., 5 km east of Amaicha, 2300 m altitude, Nov. 26, 1983 (R. B. Roberts) [Lawrence; paratypes, Buenos Aires, Lawrence, New Brunswick, Curitiba]. Other paratypes, all from Catamarca Prov., as follows: Four males, five females, Andalgalá desert site, Oct. 22 and Dec. 19, 1972; Oct. 7, 8, 9, 1973 (Internat. Biol. Prog., J. L. Neff) [Austin]. One male, Andalgalá, Dec. 10, 1972 (IBP program, desert scrub site, J. L. Neff) [Austin]. One female, Minas Capillilas, Dec. 4, 1973 (J. L. Neff) [Austin]. Three males, one female, El Pucará, Nov. 11, 1972 (IBP Research Site, J. L. Neff) [Austin]. Five males, three females, 15 km southeast of Andalgalá, Oct. 25, 1972 (G. E. Bohart) [Logan]. One female, same data but 15 km east. Ten males, five females, Joyango, Oct. 30, 1972 (G. E. Bohart) [Logan, two pairs Lawrence]. One male, two females, 35 km west of Andalgalá, Oct. 24, 1972 (G. E. Bohart) [Logan]. One male, Cuesta de la Chilca, Aug. 30, 1968 (A. Willink) [Logan]. One male, one female, Londres, Oct. 21, 1972, on *Larrea cuneifolia* (G. E. Bohart) [Logan].

Most of the paratypes collected by J. L. Neff were on flowers of *Larrea divaricata* although three males were on *Prosopis nigra* and three females were on *Bulnesia retama*. Except as otherwise noted, the paratypes collected by G. E. Bohart and A. Willink were on *Larrea divaricata*.

Other material: One male: Chubut Prov., Pen. Valdez, Nov. 25, 1973, on *Larrea divaricata* (J. Neff) [Austin].

Comments: Some of the material from J. L. Neff has been labeled by him with a Moure manuscript name meaning wooly, probably with reference to the widespread pale (although appressed and straight) hair of T2-4 of the female.

Etymology: This species is dedicated to the memory of the late Radclyffe B. Roberts who collected an excellent series of this species as well as many other interesting Argentine bees.

Colletes grisellus new name

Colletes griseus Smith, 1879:2, preoccupied by *Monia grisea* Westwood, 1875:222, transferred to *Colletes* in the present paper. *C. grisellus* is from Oaxaca, Mexico.

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